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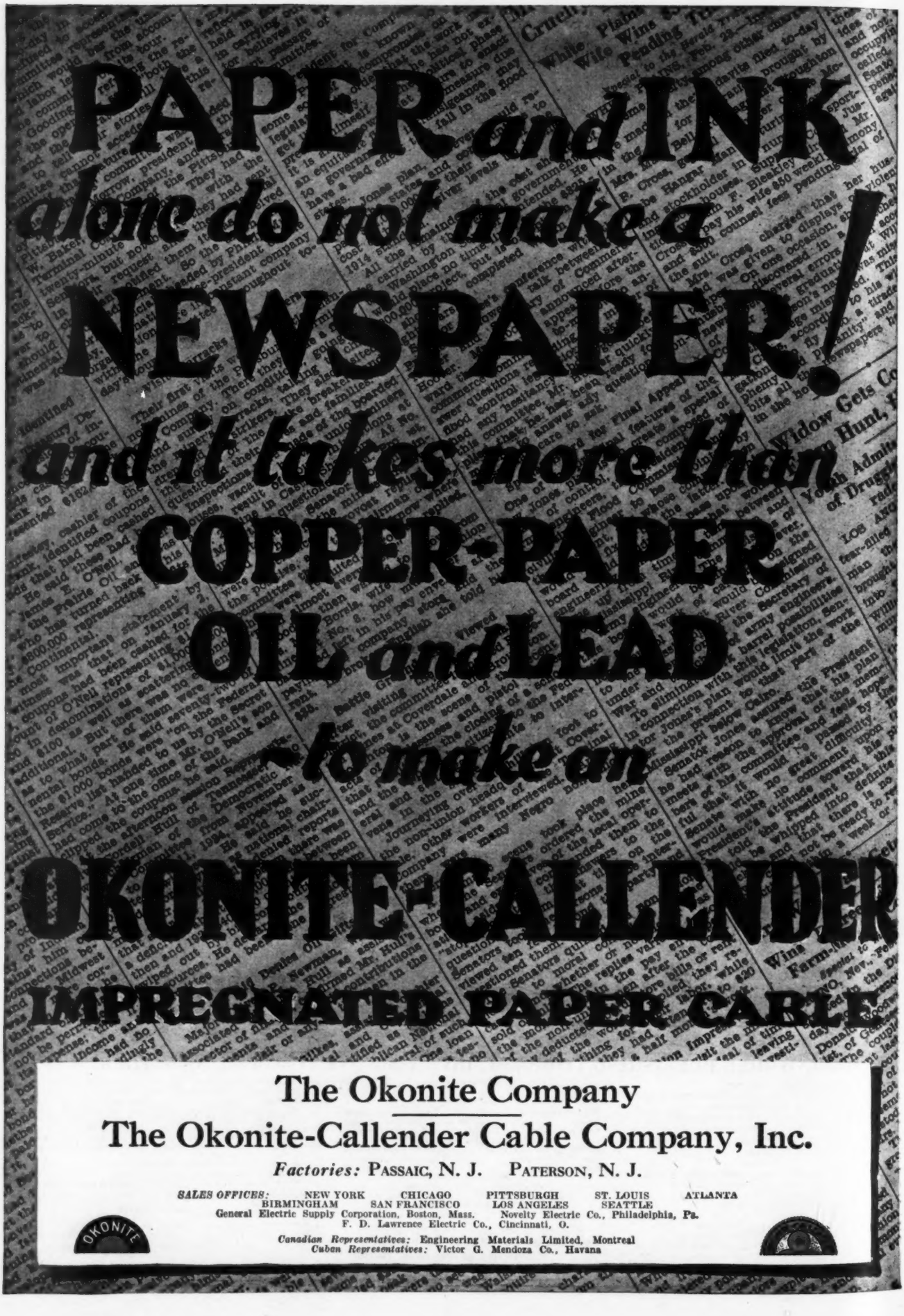

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The San Francisquito Disaster

JUST what caused the St. Francis Dam to burst in the night of March 12 and to unloose the deluge which brought swift death and destruction into the San Francisquito Canyon and the Santa Clara River Valley of southern California will eventually be revealed. The appalling fact is all that is certain at this writing, and its contemplation is far from gratifying to the engineering profession. Covering the blot for the present, however, with a mantle of charity, let us look with eyes undimmed by passion on the triumphs of engineering and of human relationships brought into action by the catastrophe.

Two generating stations of the city of Los Angeles, with an aggregate rating of 93,100 kw., are temporarily paralyzed because of the disaster. The Southern California Edison Company—thanks to its now adequate steam reserve—quickly took over the load of the municipal system and enabled the citizens of Los Angeles, so far as electricity supply was concerned, to go about their business as though nothing had happened. Magnanimous, one might say, considering the rivalry existing between the Power Bureau of the city of Los Angeles and the Southern California Edison Company; but nothing less could be expected of the Edison company. Engineering is no respecter of persons and calamity wipes out all rivalry. Besides, Chairman Miller, President Ballard and the entire Edison organization are so rooted and grounded in traditions of service that if human impulses and the needs of California did not stir them, their natural instinct for service would. The industry sympathizes with the Power Bureau in its affliction and rejoices in the fact that the Edison company so amply justified the confidence in it that every one familiar with its history and its spirit entertained.

* * * *

New York Legislature Passes Savings Bank Investment Bill

PASSAGE without debate and without opposition by the New York Assembly of the bill authorizing savings banks to invest in the bonds of public utility companies doubtless presages its approval by Governor Smith, although Democratic senators from New York City opposed it. For more than five years the savings banks of New York have tried to get the state to permit them to invest in gilt-edge utility securities and now it appears that success will at last crown their efforts. This means that the utilities of the country will find the market for their bonds considerably widened and their credit position thereby strengthened.

Savings bank deposits in New York amount to $4,000,000,000, but, of course, all of this is not available for utility investment. Under the terms of the bill, however, at least $500,000,000 could be thus employed, enough to absorb many years' offerings of bonds measuring up to the standards set. This illustrates the size of the market with relation to the volume of offerings, and it is encouraging to feel that as other states liberalize their requirements the savings banks will absorb more and more of amply protected public utility securities.

* * * *

Mass Production in Steam Generation

ON THE frontier of steam-generation developments the high-powered boiler unit is the heavy artillery of the advance. Recent improvements in furnace design centering upon the use of water-cooled walls and greatly increased volumes of combustion space point the way toward the building of boilers of colossal ratings compared with former units. Thomas E. Murray recently told the Midwest Power Conference that plans are now being made for boilers each having a capacity of 800,000 pounds of steam per hour; that the next installations will go to one million pounds per boiler, and that we may expect soon to have units large enough to supply individually all the steam required by turbines of 300,000 kw. or even greater rating. This development will not be a mere evolution of sizes, but will be accompanied by many radical changes. Mass production of steam will be the keynote of progress, however the line of development may swing toward or away from particular generating processes. Only by this means can the over-all efficiency and reliability of service now demanded by users of electricity produced from fuel be assured.

The art of steam generation bristles with interrogations. The economic values of the water-cooled furnace need to be brought out more widely from experience. The last word has not been heard from the manufacturers of refractories, if engineering history is instructive. The extent to which decentralization is desirable in pulverization systems, the place of unit dryers, use or non-use of air-heater and economizer combinations, simplification of boiler-control systems, betterment of practice in scale prevention and the choice of steam pressures and temperatures from the standpoint of dollar efficiency are all pressing problems. The performance of a commercial installation of the mercury vapor-steam process of power generation on the substantial scale embodied in the new South Meadow application at Hartford is awaited with intense interest. Other designs of steam generating apparatus are pressing for consideration here and abroad. Truly remarkable strides are being made, and while it is somewhat disappointing for the builder of a new station to be obliged to modify his plans for its enlargement almost from the day when its B.t.u.'s begin to return money on the investment, the keen struggle for over-all economic efficiency in the modern mass production of

power presses irresistibly upon designer, operator and equipment manufacturer. Growing pains are not less healthful because of their acuteness.

* * * *

Senate Favors Government Operation of Muscle Shoals

AFTER nearly three weeks of discussion, the Senate on March 13 passed the Norris bill dealing with Muscle Shoals. Senator Norris in his original measure sought to employ the proceeds obtained from government operation for experimentation with synthetic fertilizers requiring very little electricity. As the debate developed, however, Southern senators refused to abandon Nitrate Plant No. 2, which Senator Norris insisted was obsolete, and an agreement was reached whereby Plant No. 2 will be utilized to produce cyanamid, to determine whether it can compete commercially with the synthetic product. In order to secure Norris' support, however, the Southern senators had to agree to governmental distribution of power. Thus they defeated the amendment of Senator Harrison of Mississippi which would have eliminated the purely government operation feature of the Norris bill.

Under the measure as passed by the Senate, it is doubtful whether the Secretary of War will have much power to sell to the Southeastern power companies, because Plant No. 2 will require about 100,000 horsepower and states, counties and municipalities have a prior claim over private companies. Under the circumstances, therefore, and because of the fact that the power is subject to withdrawal for war purposes, the outlook for the power companies is not inviting. While no doubt an important factor influencing the vote of many senators was the "backwash" from discussions and action on the Walsh resolution to investigate the electric light and power industry, the result does not, as one senator insisted, "blaze the trail across the map of the United States for nationalizing the power industry."

The measure is now in the hands of the military committee of the House of Representatives, where other Muscle Shoals bills are under scrutiny. Whether there will be final legislation on Muscle Shoals at this session is problematical, although if the military committee reports the Norris bill favorably, the House, in its desire to rid itself of the Muscle Shoals white elephant, may approve it. The best interests of the South would decree otherwise, but politics is politics.

* * * *

Counsel Needed on What Housewives Think

MORE than any other industry in the world, the electric light and power industry touches the people. It is not like the steel industry, which sells to railroads, to building erectors, to great manufacturers, and only through remote channels affects the individual. It is not like agriculture, which reaches its objective through the miller, the baker, the canner and the grocer. It is not like any industry in the world, because it touches at first hand every class and almost every individual, and it touches them almost every day. When the smallest customer snaps a switch he is in direct and instant physical contact with the company which supplies the energy he seeks. This truth places a heavy and unusual obligation upon the electrical industry's leaders. It requires that they shall know, appreciate, sympathize with and directly serve society down to its very dregs.

There is evidence that the central-station industry has been partial to "high hats," speaking in the vernacular, and to professional dignity. But this policy is bad for business, because the business deals with the humanities. Public servants must be "folks." If they cannot themselves be "folks," they must be guided by men who are. "I know of nothing more ridiculous than a gray-haired board of directors deciding on what housewives want," says a successful advertising man. Here in a sentence is a bookful. The men who decide "on what housewives want" should be men who know housewives—men who sell to housewives—men who understand how, why and when housewives think, and about what. These men are the salesmen. The salesmen should be invited into the industry's higher councils. They are needed.

* * * *

Record of the Electrical Manufacturers' Association

THE progress which is being shown in the growth and development of the National Electrical Manufacturers' Association is an excellent example of the benefits that so often result from the patient process of making haste slowly. Last summer there were 285 electrical manufacturing companies listed in the membership and today there are 310. This in itself is significant. For manufacturers have always been by nature individualists. Industrial competition was originally just commercial warfare in which each man kept his own counsel and endeavored to outwit and to outsell his rivals. Then came the idea of co-operation. It was good and it took root. The trouble was that, as is so apt to happen, men in their enthusiasm went too far and their sound principle of co-operation for economic efficiency began to be distorted into selfish conspiracies among manufacturers against the public. Congress rallied to the defense of the people with the repressive and restrictive Sherman act and Clayton law. And manufacturers of all industries who had just begun to learn to work together were driven apart again. It has taken a long while for industry to discover what are really sound and safe purposes for organized co-operation, to regain confidence in the practical possibilities of association work and to restore a fair measure of enthusiasm.

It was natural, therefore, that when the electrical manufacturers year before last combined their apparatus and supply groups in one organization they should go forward cautiously. This spirit has been apparent in their meetings. Vigilant counsel has been a conspicuous brake on action, that the slightest appearance even of evil thought might be avoided. And this, of course, was right. Many have been impatient at times, however, that more constructive activities have not been undertaken more quickly. This is unavoidable until a revision of these laws some day shall give to industry the right to plan and build more freely in the public interest, in tune with the advancing thought of our increasingly industrial America.

The important point is this, that the N.E.M.A. is growing. It has more members, and these companies are gradually discovering and developing the elements of common interest and common purpose on which they may profitably work. Such groups must learn to discuss

their problems freely together before they can expect to help one another solve them. The great need is always for facts, for the light of economic truth on which to base discussion. So they have been evolving a code of ethics and merchandising principles, and already eighteen sections of the association are compiling industry statistics on classes of products. These figures are incomplete and inadequate, but here is a start, of vital value to all branches of the electrical industry. And "Nema" should have the sympathy and support not only of all electrical manufacturers but of all electrical men.

* * * *

Mechanization and Unemployment

IT IS alleged that mechanization of industry and the use of power produce unemployment and that existing conditions reflect this development in American industry. Some so-called cultural writers and some labor agitators seize this statement and use it with much apparent satisfaction. From census statistics it can be shown that present production methods can accomplish the 1914 volume in manufacture with about 30 per cent decrease in the number of workers and that this trend continues. Other data show that while the productive output per worker increased 40 per cent between 1914 and 1925, in the same period the total manufacturing production increased 65 per cent. Expanded markets because of lower costs of goods not only absorbed the 30 per cent of workers but called for 1,500,000 more workers in manufacturing plants. An increase of 1,500,000 workers and the use of 13,750,000 hp. additional power resulted in an increase in production of $39,000,000,000 in the twelve-year period.

The process of mechanization is a gradual one in all branches of industry, and in each branch it makes for employment instead of unemployment. It has made an increase of 40 per cent in national wealth and in national income since 1914. It has made possible new industries and the relocation of workers in a manner enabling them to secure continuous employment despite fluctuating business conditions in any single industry. It has reduced the cost of management 10 per cent and doubled the wages of workers since 1914. There is no basis for dire forebodings as to unemployment because of the mechanization of industry. This trend in the past as in the future offers the greatest available tool to improve the status of workers and lift them out of the "coolie" standards of living, if such standards still prevail in any occupation.

* * * *

Interchange Energy Introduces Metering Problems

ON TRANSMISSION systems with extensive interconnections across state lines a difficult metering problem is encountered. For many reasons it is desirable to know the exact electrical quantities at each state-line crossing, but it is questionable whether the cost of metering equipment can be justified. At present very little energy crossing state lines is metered accurately, because values are based on generating-station energy measurements, energy sold to customers and estimated line loading and losses.

Generating-station metering is accurate and detailed for each hour of the day, but customer meter readings are monthly summations. As a consequence it is difficult to fix exact values for hour-by-hour or day-to-day kilowatt-hours and kilovolt-ampere-hours which cross state lines. Line loading changes rapidly, and electricity may flow in either direction during each day. With complex transmission systems it is difficult to draw an exact system load map for each day, and estimates are far from accurate.

Data on state line interchanges or at connecting points between utility systems have value largely as statistics and mean little to economic operation. Such data would help in allocating loadings for lines and stations more accurately, but it is questionable whether this would warrant a large investment in metering equipments. If a recording metering equipment for these applications can be developed at a low cost, there is little doubt that it would be used very extensively. The precision required is less than that for meters used in billing customers, and it would seem possible to develop high-tension metering equipment for this special application at a reasonable cost and in such a way as to decrease the service hazard introduced by current methods of metering.

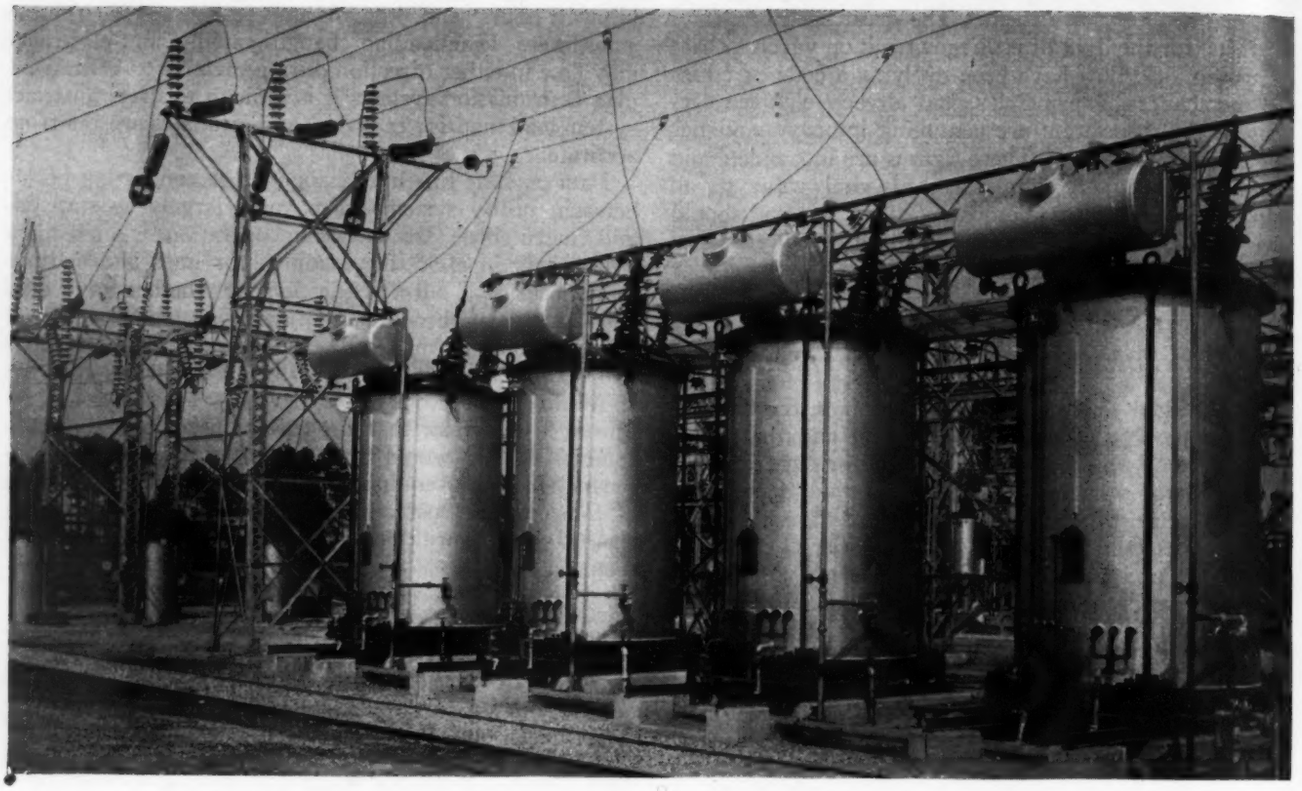
* * * *

Prime Movers and Interconnection Stability

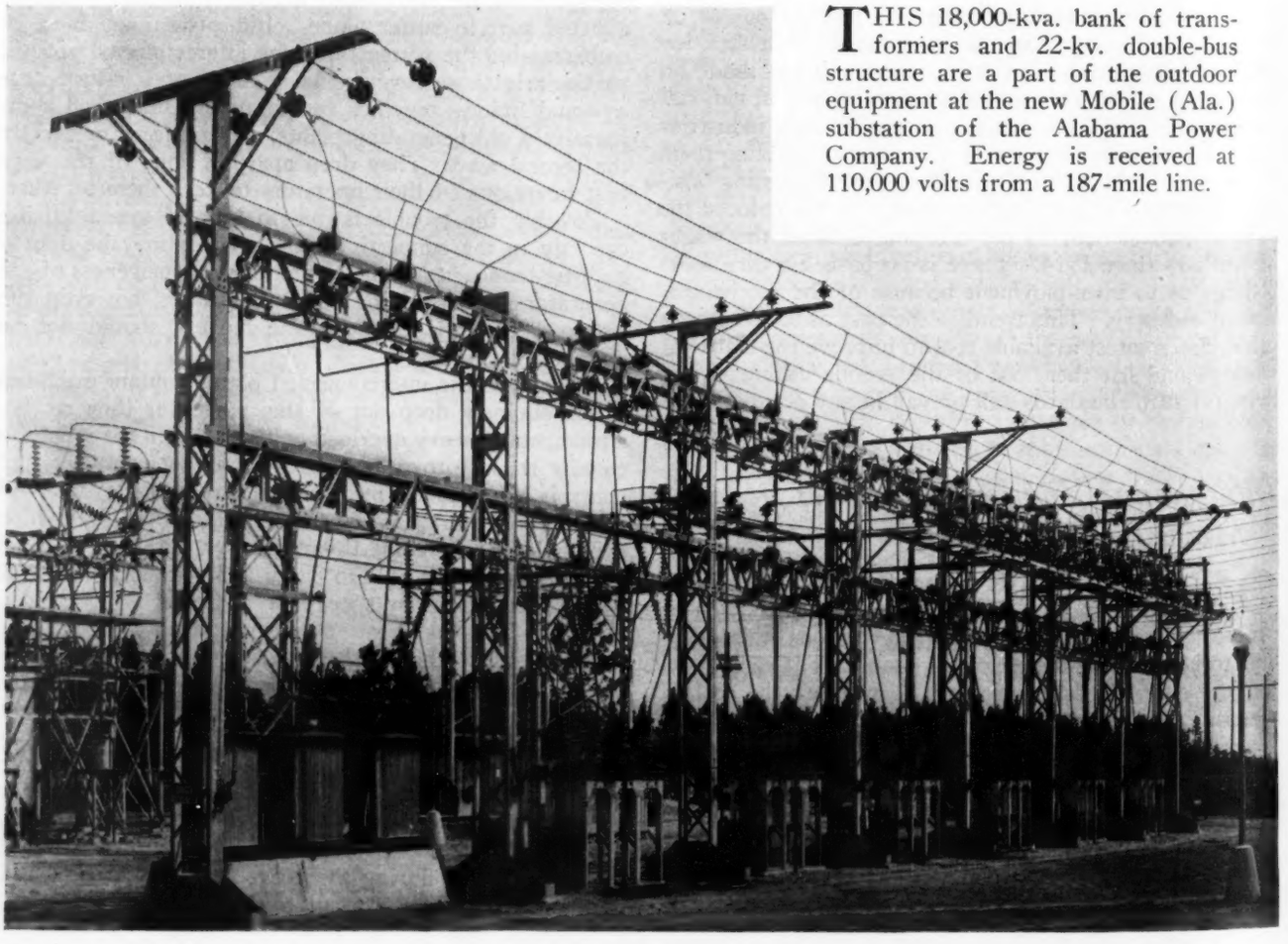
WITH some reservations, the stability of interconnections between electrical systems is a measure of their value. It is not suggested that interconnections shall be so solid that in case of major trouble all of the systems shall stand together and valiantly and uselessly go down together. Neither is it intended that when a relatively small disturbance occurs they shall immediately separate like the sections of a glass snake and leave the afflicted part to suffer alone. But often enough to be embarrassing the systems in some interconnected groups, particularly those covering large areas of low-load density and linking together comparatively small and comparatively old generating plants, will perform in exactly the second way. They drop apart in spite of the very best intentions of their operators to keep them together.

Possibly the trouble is due to lack of synchronizing capacity in the connecting lines. Or it may be due to hunting tendencies or the excitation responsiveness of the generators. In avoiding such weaknesses, however, the overload capacity of the prime movers should not be overlooked.

Sometimes the interconnected plants contain machines which supinely drop out of step whenever they receive a momentary heavy overload or secede from the union on equally trivial provocation. One holding company that controls a series of interconnected properties has laid down a policy in prime-mover purchases that is designed eventually to overcome this difficulty. All turbine units are specified to be able to carry a 50 per cent overload without reduction in speed for a period expressed in minutes. This specification does not affect the generator design, because the overload period is not long enough to produce an appreciable temperature rise. It affects only the steam end of the unit and in such a way as not to increase the cost or to decrease the normal operating efficiency. A unit of this kind will, of course, require that the boilers and auxiliaries be competent to carry their share of the overload. This requirement, however, merely makes it necessary that the overload performance be kept in mind during the course of plant design and shall not add greatly, if at all, to the cost.



New Automatic Substation in the South



THIS 18,000-kva. bank of transformers and 22-kv. double-bus structure are a part of the outdoor equipment at the new Mobile (Ala.) substation of the Alabama Power Company. Energy is received at 110,000 volts from a 187-mile line.

Single-Phase Condenser Motor

Fractional horsepower motor characteristics, effect on economy of operation, application requirements, condenser motor theory and operation discussed

By Prof. BENJ. F. BAILEY
University of Michigan

UNTIL recently the users of small motors were interested only in price and reliability. Motors used for such purposes as operating vacuum cleaners, sewing machines or fans run only a small portion of the time and the cost of the energy consumed is negligible. The user is therefore not interested in efficiency, and as a rule knows nothing about the power factor or other characteristics of the motor. The central stations were not particularly interested since the connected load was small and was on the line only a small part of the time.

With the common use of electric refrigerators and oil burners requiring an electric motor the situation has radically changed. Such motors are used in enormous numbers and they are in operation a large percentage of the time. The user therefore should be interested in efficiency, since his monthly bill is considerable.

The average domestic refrigerator if equipped with some of the low efficiency motors now on the market will consume 750 kw.-hr. per year. By using the most efficient type of motor this may be cut to 500 kw.-hr. If energy costs 5 cents per kilowatt-hour the better motor will effect a yearly saving of $12.50. The saving in one year will easily pay the difference in cost between the two motors. In addition, the type of motor herein described is notably quieter than the usual single-phase motor and causes less interference with radio reception.

The progressive central station is interested in seeing that the motors on its lines are high in efficiency and power factor and require a low starting current. A low efficiency motor of course consumes more energy and therefore increases the central station revenue. On the other hand, small bills encourage the use of electrical appliances. When high-efficiency electric lamps replaced the old carbon-filament lamps the consumption of energy by no means decreased, but, on the other hand, showed a marked increase. Doubtless an improvement in motor efficiency would have a like effect in increasing consumption.

The central station is paid only for the energy consumed, since it is impracticable to meter power factor in domestic installations. The refrigerator and oil burner motors both operate on the peak of the load. A motor of low power factor is bad from the standpoint of the central station, since it requires a large current and consequently larger generators, feeders, transformers and switches. The best available ¼-hp., 110-volt, alternating-current motors require a current of only 2.5 amp. at full load, while the worst require 6.5 amp. It is rather surprising to find that to supply the better motor a metropolitan central station must make an investment of approximately $55 and for the poorer one $78, a difference of $23. The difference in cost between the two motors is far less than this. When a better motor is used the central station also gains by reason of better voltage regulation and lower losses in its feeders, generators and transformers.

Realizing the importance of the growing small motor load the Detroit Edison Company some three years ago financed an investigation of the characteristics of the fractional horsepower motors actually on the market, and about 25 small single-phase motors were carefully tested by the writer and his assistants. Some of the results obtained are shown in Figs. 1, 2 and 3. These motors

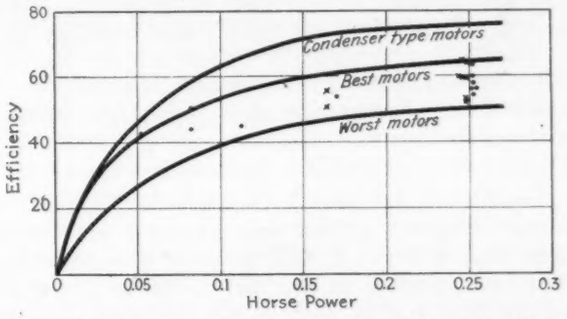


Fig. 1—Efficiencies of small motors, 110-volt, 60-cycle, 1,800-r.p.m. Split-phase motors indicated by dots and repulsion-induction motors by crosses

are of the repulsion-induction and split-phase types. No condenser motors are included.

In Fig. 1 the full-load efficiencies of the motors tested have been plotted and two curves drawn showing approximately the best and the worst efficiencies of the present day commercial motors.

Considering, for example, the ¼-hp. motors, a simple calculation shows that the worst motors on the market, with efficiencies of about 50 per cent, consume about 373 watts at full load. The best commercial motors, with 64 per cent efficiency, require only 292 watts. If we compare the monthly bills of consumers using the poorest motors with those using the best motors it can be seen that there is a difference of 28 per cent.

On the same curve sheet I have also plotted full-load efficiencies which have actually been obtained with the condenser motors to be described later. It is entirely possible to obtain an efficiency of 75 per cent with a ¼-hp. condenser type motor. Such a motor would require only 250 watts for full-load operation and the monthly bill would be approximately two-thirds as great as with the poorest of the present-day motors, or approximately 85 per cent as great as with the best of the present-day motors.

In Fig. 2 I have plotted corresponding curves showing the power factor of small motors. The difference

between the poorest and best motors is approximately the same as before. The upper curve shows power factors which can readily be obtained with condenser type motors. By using somewhat larger condensers it is perfectly possible to raise the power factor to 100 per cent, or even to cause the motor to take a leading current. In fact, condenser type motors are now on the market having power factors of more than 95 per cent. How high we should go is merely a question of how much it is worth while to invest to secure a high power factor.

In Fig. 3 I have shown the apparent efficiencies of small motors. The apparent efficiency is obtained by multiplying together the efficiency and power factor. Since the motors which have the lowest efficiencies usu-

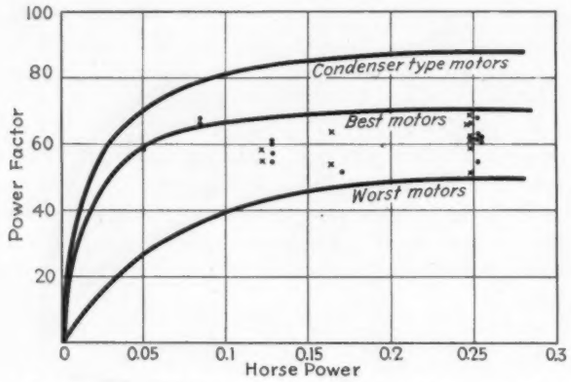


Fig. 2—Power factors of small motors, 110-volt, 60-cycle, 1,800-r.p.m. Split-phase, dots; repulsion-induction, crosses

ally have the lowest power factors as well, the divergence between the curves of best and poorest motors is even greater than before. It will be noted that some ¼-hp. motors have an apparent efficiency as low as 25 per cent, while the best run as high as 43 per cent. The condenser motor can easily be built to have an apparent efficiency of 65 to 70 per cent. The current required by such a motor is not much more than one-third of that of the poorest present-day motors and about two-thirds of that required by the best motors of other types. It is obvious from the standpoint of the central station that it is much cheaper to provide facilities to supply a motor requiring less than 2.5 amp. at full load than to supply one requiring 6.5 amp., and it is equally obvious that it is to the advantage of the customer to receive a monthly bill of $2 rather than one of $3.

Split-Phase and Repulsion-Induction Motors

The circuits of a split-phase motor are shown in Fig. 4. The primary winding is usually on the stator, although it is sometimes placed on the rotor, and consists of a two-phase winding wound in slots. The winding marked 1 is the main or running winding. Winding 2 usually has fewer turns than winding 1 and is wound with finer wire. The switch S is ordinarily automatically operated by centrifugal force, so that it opens when the motor attains its running speed. The non-inductive resistance marked R is rarely present as a separate element, but the necessary resistance is secured by using finer wire in winding 2. This has the obvious advantage of cheapness. The rotor is usually of the squirrel-cage type.

When a motor must exert considerable starting torque with a low starting current the repulsion-induction type of single-phase motor is preferred. The stator is similar to that of a split-phase motor except that only a single winding is used. The rotor is like that of a direct-current motor having a commutator and brushes. These brushes are short circuited to one another and are not connected to the supply circuit. When the motor reaches nearly full speed a centrifugal device operates and short circuits the bars of the commutator to one another. The motor then operates as though it had a squirrel-cage armature. Its characteristics during normal running do not differ materially from those of the split-phase motor.

Split-Phase Motor Starting

The vector diagram of a split-phase motor when starting is shown in Fig. 5. I_1 represents the current in the winding 1 and it lags by a large angle behind the voltage E. The current I_2 in the winding 2 lags by a much smaller angle due to the fact that this winding has a relatively high resistance compared with its reactance. The two currents are therefore at an angle α.

For the best results this angle α should be 90 deg., but it is obviously impossible to secure such an angle with this construction. The starting torque developed is proportional to the ampere turns in each of the windings, namely N_1I_1 and N_2I_2, to some constant which we will call Q and to the component of I_2, which is perpendicular to I_1. It is then given by the formula

$$\text{Starting torque} = QN_1N_2I_1I_2 \sin \alpha.$$

In order to get sufficient starting torque in motors of this type it is necessary to make N_2 small. For a given size and weight of wire the impedance of the winding 2 is proportional to the square of N_2 and the current of I_2 is therefore inversely proportional to the square of N_2. The product N_2I_2 will therefore become greater as N_2 becomes smaller and the starting torque will be correspondingly increased. The number of turns N_1 in the main winding is of course fixed by the design of the motor and cannot be made unduly small without impairing the characteristics of the motor. Such a motor will quite obviously take a large starting current and develop only a comparatively small starting torque. The starting torque can, however, be made from 150 to 200 per

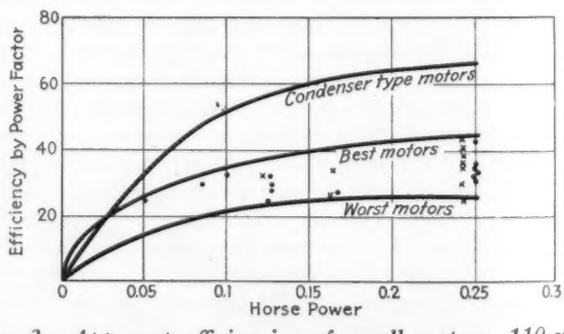


Fig. 3—Apparent efficiencies of small motors, 110-volt, 60-cycle, 1,800-r.p.m. Split-phase, dots; repulsion-induction, crosses

cent of the full load running torque, but only at the expense of a large starting current.

The starting efficiency of any motor can be determined by the following formula:

$$\text{Starting efficiency} = \eta = \frac{0.142\,TS}{\text{Volt-amperes}}$$

in which T is expressed in pounds feet and S is the synchronous speed in revolutions per minute. In the case of a polyphase motor proper allowance for the number of

phases must of course be made in computing the volt-amperes.

The starting efficiency of a shunt-wound direct-current motor as determined by this formula is nearly 100 per cent, S in this case being the free running speed of the motor. In the case of an alternating-current motor, S is the synchronous speed and the starting efficiency is lower. For a squirrel-cage polyphase motor it is in the neighborhood of 20 per cent and for a wound-rotor polyphase motor about 50 to 60 per cent. In the case of the split-phase motor it is very low, being about 8 to 10 per cent. In other words, such a motor takes about ten times as much current for the same starting torque as a shunt-wound direct-current motor.

Under normal running conditions the switch S is open

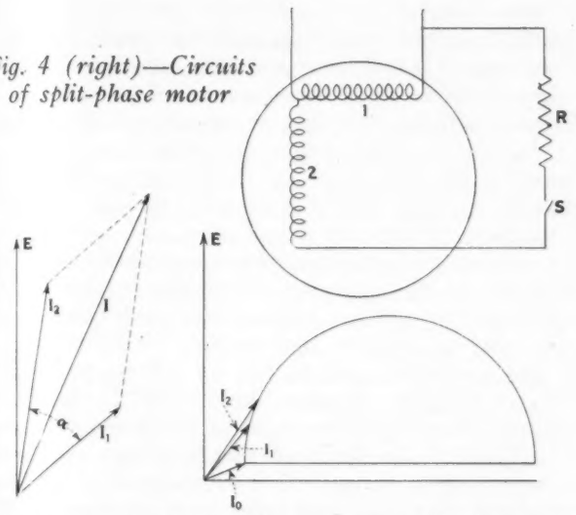


Fig. 4 (right)—Circuits of split-phase motor

Figs. 5 and 6—Vector diagrams for split-phase motor, starting and running, respectively

and the winding 1 is alone active. The vector diagram of such a motor at full load is shown in Fig. 6. The current is shown lagging behind the voltage by a considerable angle. As is well known the locus of the end of the current vector for varying loads is approximately a circle. The current at very light loads is represented by such a vector as I_0, at full load by such a vector as I_1 and for overloads by such a vector as I_2. The power factor can never be 100 per cent. In general, it increases with the load up to about 50 per cent overload; beyond that it decreases.

Compared with a polyphase motor, such a motor has the disadvantage that it requires a very large starting current. Its output is small since the running winding occupies only a portion of the available winding space and its power factor is lower than that of a polyphase motor.

[The second part of Professor Bailey's discussion of the single-phase condenser motor will appear in an early issue.—EDITOR.]

Hydro Plant Taps Two Watersheds

THE Great Falls hydro plant of the Tennessee Electric Power Company utilizes the waters of the Caney Fork River and also draws a supply through another penstock from the Collins River, which flows on the far side of a mountain ridge behind the plant. These two streams afford a reservoir equivalent of 6,000,000 kw.-hr. for the station, whose capacity is 35,510 hp.

Long Cable Sections Reduce Expense

Decrease number of manholes, splices, bonds, fireproof coverings, operating hazard, cost of cable, handling and installation

By C. H. SHAW

Engineer Distribution and Installation Department, New York Edison Company

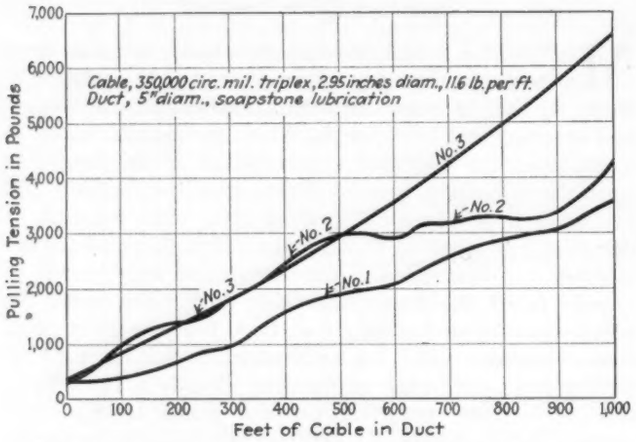
MANHOLES and conduit structures are far more permanent than any cables that may be installed in them, so that in every important installation the design and arrangement of these facilities are usually based as much upon the expected requirements of the future as upon the immediate needs. The cost of the conduits and manholes is always very much greater than the cost of the cables installed in them, and when a large allowance is made for later growth the investment may be ten to twenty times the immediate cable cost. But since the increment cost of building one, two, four, or eight additional conduits, after the excavation, backfilling and repaving have once been undertaken, is only a fraction of the cost of the complete project, extra facilities are usually included with the original construction to secure the ultimate minimum cost per duct-foot of conduit.

Several new conditions have caused very rapid advancement in the design of underground conduit systems during the past two or three years. First, the unprecedented increase in the operating voltages for which cables have been designed has made it imperative that the detail arrangement of the cables in the ducts and the training, method of support and splicing of the cables in the manholes shall have expert engineering supervision; second, the introduction of large single-conductor cables, installed either singly or in multiple in the ducts, has made it advisable to increase the diameter of the ducts for many important feeder lines from the old standard of 3 in. to 5 in.; third, with the continuing advance in the operating voltages of underground transmission cables and the steadily increasing size of the generating units that are installed in the power stations it is important that the relatively permanent conduit structures be built of such sizes as will not in the future restrict the use of larger and higher voltage cables.

When the monolithic concrete conduit system that was later to house the highly successful 132,000-volt feeder cable in New York was under construction there were no data available upon which to base a decision as to the maximum length for which the conduit sections should be designed. But with the later adaptation of a continuous reading dynamometer, from which the pulling stresses required to draw cable into ducts could be secured readily, it became possible at once to develop new and more efficient methods for lubricating the cable during the pulling-in process and to discover the most advantageous lubricant for each type of conduit. These tests showed that the friction between the cable and the concrete walls of Murray monolithic conduits was almost entirely dependent upon the unit weight of the cable itself, as long as the cable was not too large for the duct.

Long sections of cable have several advantages. They reduce the number of manholes that are required in a given line and, as manholes are expensive, effect an important saving in the initial cost of construction. With a reduction in the number of manholes there is a cor-

responding saving in splicing, bonding and fireproofing of cables. The manholes are unquestionably more hazardous for the cables installed in them than are the individual ducts entirely surrounded by concrete. The cost of manufacturing long sections of cables is less per foot than for short sections, since all of the fixed processes, such as reeling up, impregnating, testing and crating, are almost independent of the length of cable section. With double the length of cable the unit cost of these processes



Tensions required to pull three 1,000-ft. cables into Murray monolithic duct

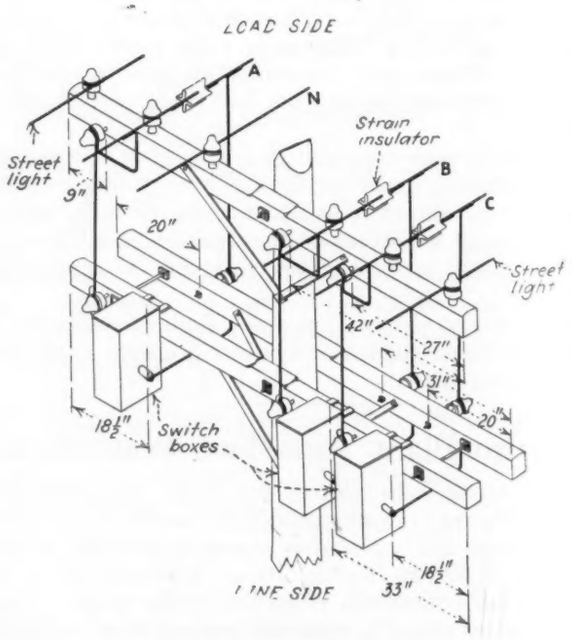
is halved. The cost of installing one section of cable 1,000 ft. long is much less than the cost of pulling in two sections of 500 ft. each, and the investment in reels, cost of carting the cable to the job and of handling the empty reels is almost half as much per cable-foot for the long section as for two short ones.

After the completion of the tests that revealed the low coefficient of friction that exists in properly lubricated Murray monolithic conduit structures, it was decided to build the maximum-length sections for which cable could be manufactured on an important underground transmission system from Dunwoodie substation in Yonkers to the Elmsford substation in Westchester, a distance of 11 miles. As the highway has a great many curves, only a few 1,000-foot straight sections could be fitted in. And as three single-conductor, 45,000-volt cables are to be placed in each duct the total weight of cable per duct-foot probably will be greater than ever before installed in so large an undertaking. In the first 7,000-ft. portion of the line to be finished there are three 1,000-ft. sections. With the completion of a series of trial tests it has been found that it will be practical to place the three 45,000-volt cables in one duct. All of these will not go in at one time, but will be installed in two operations, which will call for one cable first and for two cables to be drawn in over the first one in the second pull. The maximum pulling stress will not exceed 5,000 lb. per cable.

Over a portion of this line provision was made for the additional installation of two 13,200-volt feeders, and because of some unexpected developments it happens that one of these lower voltage feeders was the first to be installed for permanent operation. The installation of the three-conductor, 350,000-circ-mil triplex cable introduced an interesting problem, as the cable for this job was used cable, on hand in relatively short sections. These sections were duct-spliced in the salvage plant of the New York Edison Company to lengths of not more than 500 ft., this being the maximum length of this size cable that can be placed on a large standard reel. In order to install the 1,000-ft. sections a 500-ft. piece was first pulled in, with the end left above ground so that the duct-splicing crew could bring its equipment into the field and make a duct splice between the two 500-ft. sections, after which the cable was pulled in the remaining distance. This procedure was followed in several other sections of less than 1,000 ft. where the cable could not be placed on a single reel. The pulling tension of each of the three 1,000-ft. sections is shown in the accompanying diagram. The duct curve No. 3 had a slight bend in it, which accounts for the greater stress required than in the two other cases. This feeder, upon completion, was tested at 67,000 volts direct current for five minutes with a portable kenotron set and was found free from fault. If new 13,200-volt cable had been used it would have been made up as three single-conductor sections, each 1,000 ft. long and each on a separate reel. All three sections would have been pulled in together.

Unless manholes and duct entrances can be designed for expansion and contraction long cable sections cannot be used as the lead sheaths would crack. Experience shows that devoting careful study to the details of conduit and manhole design and construction not only reduces unit costs but produces much more acceptable cable operating conditions. The day of building important conduit lines without accurately prescribed grades and curves is over, and to consider that conduit construction is a mere pick-and-shovel job, as has been done all too frequently in the past, is much like leaving the design of the façade of an expensive building to the master bricklayer. While the developments that have been mentioned have been largely in connection with monolithic conduit construction, the tests that have been reported by the more important utility companies throughout the United States show an increasing appreciation of the importance of adequate engineering supervision.

Mounting Disconnects for 4,000-Volt Circuits



Standards of West Penn System

Capital Investment Rate Base*

Economic defects of proposed Massachusetts plan of regulation. Inflation likely to follow application of price fixing to maintain stocks at par. Public welfare faces risks if bill passes

By PHILIP CABOT
Head of Public Utility Courses
Harvard Graduate School of Business Administration

A BILL before the Massachusetts Legislature (House 170) embodying the recommendations of the Governor and indorsed by the Department of Public Utilities proposes to create a new relation between the companies and the state by means of a contract fixing the amount paid in by the stockholders for stock and premiums as a permanent rate base on which the stockholders are entitled to receive a fair return, and rates are to be regulated in such a way that the profits of the companies shall be sufficient, but not more than sufficient, to keep the market price of the stocks at or above par. The object of this legislation is to obtain a necessary service for the consumers at the lowest possible price. This object is sound and wise, but I do not think that it can be reached by this method, because it violates certain fundamental economic principles. I shall confine myself strictly to these principles.

RATE BASE MEASURED BY 65-CENT DOLLARS

The reason that this problem has arisen at this time is because of the wide divergence between the original cost of these utility properties and the present cost of reproducing them. This is an economic phenomenon observable in all business. There has been a general rise of prices since 1914 and the wholesale price index figure now stands at about 147, as compared with 100 in 1914. Now all economists agree that a general rise in prices is merely another way of saying that the value of the dollar has fallen. What has happened in this case is not that the prices of goods measured in other goods have risen, but that the yardstick with which we measure the goods is shorter. Values in most cases are not really higher than in 1914, but the dollars in which we measure them have shrunk to 65 cents.

What is proposed is that the property of these public utility companies shall be measured in these 65-cent dollars and that the value thus found shall be adopted as a permanent rate base and used to fix just and reasonable rates. Disregarding the possible injustice to investors of such a course, it would seem to be advantageous to the consumer because the purpose is to fix values at a low figure so that prices may be low and the consumer may benefit. If the value of these properties were measured by comparison with the prices of other goods and services; that is, on the basis of cost of reproduction new, the values and therefore the prices would be much higher.

Such consideration for the welfare of the consumer is commendable, but the question arises whether in the long run it will really benefit the consumer. I hold that it will not.

When prices rise, as they have in the last twenty years, it indicates primarily an increase in the demand for goods. For example, when the cost of building material rises it shows that more people are building houses, thus creating a demand for such material. Under normal conditions such a rise of prices works in two ways: (1) It tends to control the increase in demand, and (2) it tends to stimulate production of these materials and increase the supply. Prices will continue to rise until the demand is checked and the supply has increased, so that equilibrium has been re-established.

Now in the public utility business, production is increased by law; the companies are required to supply all the service that is demanded,† and under the method of regulation proposed by this bill prices, instead of rising to check the demand, are to be reduced. Thus the demand will be stimulated instead of being checked and the business will be expanded more rapidly than it would have been if the check of rising prices had been applied. Lowering prices always have the effect of increasing demand when the market is what economists call an elastic market. Most markets are more or less elastic—that is common knowledge—and the market for gas and electricity is very elastic, as the experience of the last twenty years has proved. It is, therefore, as certain as any economic result can be that if prices are reduced at the present time, when the demand for these services is excellent, the business will expand at a rapid and an abnormal rate.

PRICE FIXING BEGETS INFLATION

This increased demand will require the expansion of the producing and distributing plants of the companies, and the expansion of them at a time when prices are high. The stimulation of demand by a lowering of price will force an abnormal expansion of plants and is likely to result in an overdevelopment of these industries. We have an ugly name for this sort of thing; we call it inflation, and it is a thing which we have learned to fear. It has often resulted from the efforts of governments to fix prices; in fact, it is the usual result, and we know that the ultimate effect on the consumer is bad.

The danger of inflation which I apprehend as a result of the method of price regulation proposed by this bill is the same as the dangers of currency inflation, with which you are all familiar, except that currency inflation affects all lines of business and this inflation will affect the public utilities alone. But the investment in them is

**From an address to the legislative committee on power and light at Boston.*
†Except in case of unprofitable extensions.—[EDITOR.]

already very large, and if inflation of this industry is forced upon us by the action of the state the damage will be serious.

The matter is so important and the danger of it so great as to warrant a more detailed explanation. This is the way in which I think the thing will work. The demand for gas and electricity will be stimulated by low prices fixed by a rate base which will be about 50 per cent below the present cost of reproducing the properties. This increased demand will require the rapid expansion of the properties in the immediate future when prices of labor and material are high. As long as the prices are held artificially low, demand will continue to expand until a condition of inflation results. Under this bill the new plants will be paid for by new security issues, on which the state must practically guarantee a fair return because the stocks are to be maintained at or above par.

As long as the business continues to expand no difficulty will be encountered, but ultimately the end must come. A turn in the business cycle will come, demand will begin to fall and depression will set in. Then we shall be in trouble. The industry will be overexpanded; as demand falls off a large part of the plant will be idle, and revenues at current rates will be insufficient to pay fixed charges. An increase in rates will be necessary in order to maintain the prices of the stocks and this increase will come just at the time when there should be a decrease. Other prices will be going down, other business will be depressed, and in order to lift industry out of its depression lower prices for gas and electricity for industrial uses ought to be made. But that will be impossible. Regulating commissions will never stand the odium of raising prices for domestic service in order to help business. The rates for domestic service will stay down and rates for industrial service will have to bear the whole increase. The resulting burden on the community is difficult to gage, but it may be staggering.

Bad Effect on Business Cycle

There is another economic angle from which this can be seen. The best brains in the country are being applied to finding some way to do away with the evils of the business cycle, or at least to mitigate the severity of it, but if this method of public utility rate regulation should be generally adopted the severity of the cycle would be very greatly increased. Artificially low prices in times of prosperity will force the utility companies into the market for labor and materials at the very worst time; that is, when prices are highest because business is good. When the depression comes the utility companies will be out of the market because their plants will be overbuilt and, to make matters worse, they will have to exact an increased price from industry when it can least afford to pay it.

By agreeing to fix rates which shall enable the companies to keep the prices of their stocks above par the commonwealth is repeating the blunder made in the public control act for the Boston Elevated Railway. Dividends in the stocks of the gas and electric companies will not be guaranteed, but when depression comes prices will have to be raised so that dividends can be earned, while the stockholders, who ought to take the risks of the business, sit back and let the commission do the worrying.

I am led to believe that this is a sound forecast of what may happen in the gas and electric industries by the example of what has actually happened to the electric street railway companies. These companies did, without intending it, just what I have described above. In fixing the 5-cent fare they set the price too low; the result was a rapid expansion of the business, ending in overexpansion, and when they tried to retrace their steps by raising their fares they found that the amount of business which they could get at the higher prices was too small to pay a fair return upon the plant. In most cases the stockholders stood the loss, but if the state had agreed to fix fares at a point which would keep their stocks above par the dilemma would have been serious, because we know by experience that there are many cases where no rate of fare which the public will pay is high enough to earn a return on the capitalization of the street railways. Just such a condition may arise in the gas and electric industry if the provisions of this bill are carried out. The plants of the companies may be expanded beyond the point where any rates that can be collected in times of depression will keep the stocks of the companies at par. In such a condition the state would be helpless. It would have agreed to fix prices which would accomplish this result, but it would be beyond its power to do so. Even the Commonwealth of Massachusetts must bow before the economic law. But the situation would be most humiliating and it is unnecessary.

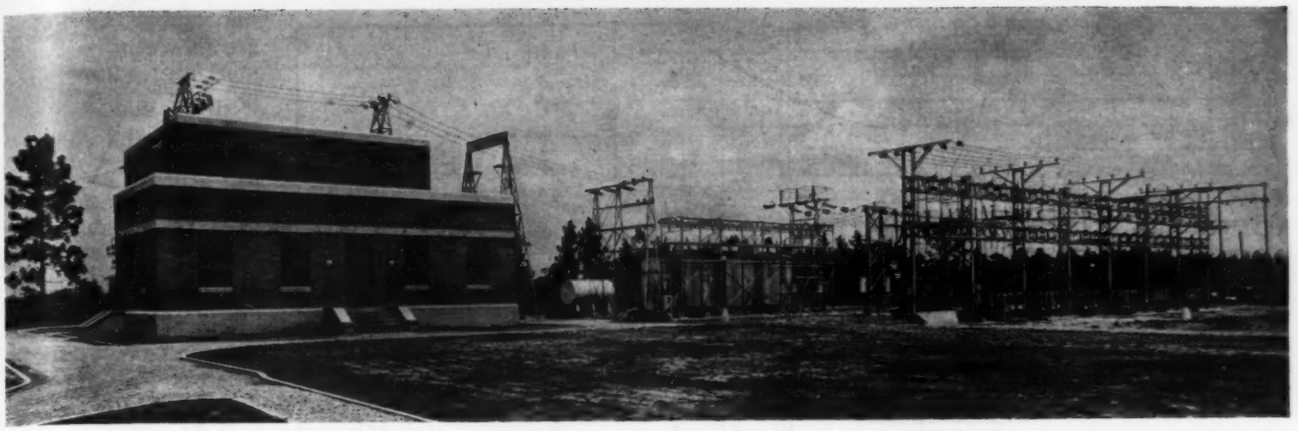
There are already visible upon the horizon clouds which indicate that inflation is at hand in certain places in the electric power industry. This may perhaps be due to public regulation as now generally practiced, but the point is not clear. A certain rigidity in price regulation is unavoidable under any method of government control. There is bound to be delay in adjusting prices to changing market conditions, and the atmosphere of controversy and the spirit of litigation which hang like a cloud over all rate inquiries before the regulating commissions tend, so to speak, to make the visibility low. But the present methods have this great advantage over the method proposed by this bill. If inflation comes, and is followed by collapse in some cases, the state is not responsible for the losses which may ensue. These will fall where they belong, upon the stockholders.

I conclude, therefore, that the method of regulation proposed by this bill is not in the interest of the consumer. In the long run he will suffer, because this method violates a fundamental economic law, the law of supply and demand. The rigid rate base chained to the dollar is artificial and very dangerous.

If the rate base instead of being made rigid at an arbitrary point is allowed to move naturally with the price level and if prices are allowed to move up and down with other prices the dangers of overexpansion will be avoided. Cost of reproduction is a far safer rate base for the consumer than capital investment, because it will tend to check inflation, prevent overexpansion and keep the industry healthy.

Hydro-Electric Development in China

A HYDRO-ELECTRIC generating station has recently been completed near Yunnan, in the southeastern part of China. The installation comprises two stations working in series, one with a head of 47 ft. and the other with 52 ft. Each is equipped with one 300-kva., 3,300-volt generator. The power is stepped up to 23,000 volts for transmission over a distance of about 20 miles.



Mobile substation follows Southern trend toward automatic equipment

Hydro Power on the Gulf Coast

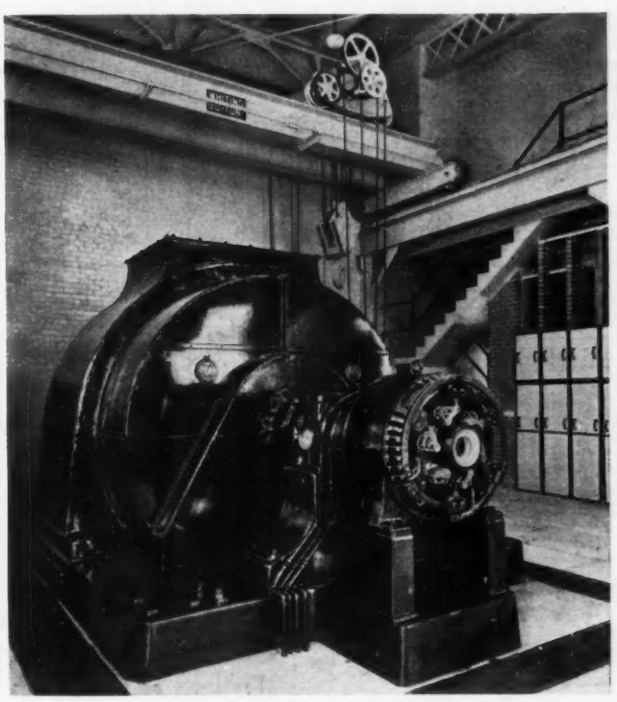
Mobile, Ala., is second coast city to obtain power from streams of the South. Automatic operation of step-down substation with synchronous condenser described

By L. M. SMITH and M. S. MERRITT

Engineering Department, Southeastern Engineering Company, Birmingham, Ala.

"ON FRIDAY, Jan. 7, 1927, with appropriate public ceremony, hydro-electric power was ushered into the city of Mobile—Alabama's venerable and romantic 'City by the Sea.'" This brief statement of fact as read by the public in the daily press has in it, as every engineer knows, volumes of interesting but unchronicled studies, figures and experience that embrace between their inception and realization years of patience. The serving of Mobile, second city on the Gulf to receive hydro power, was no exception, and, if anything, more than the usual amount of study was necessary, as a glance at a map of southern Alabama would indicate.

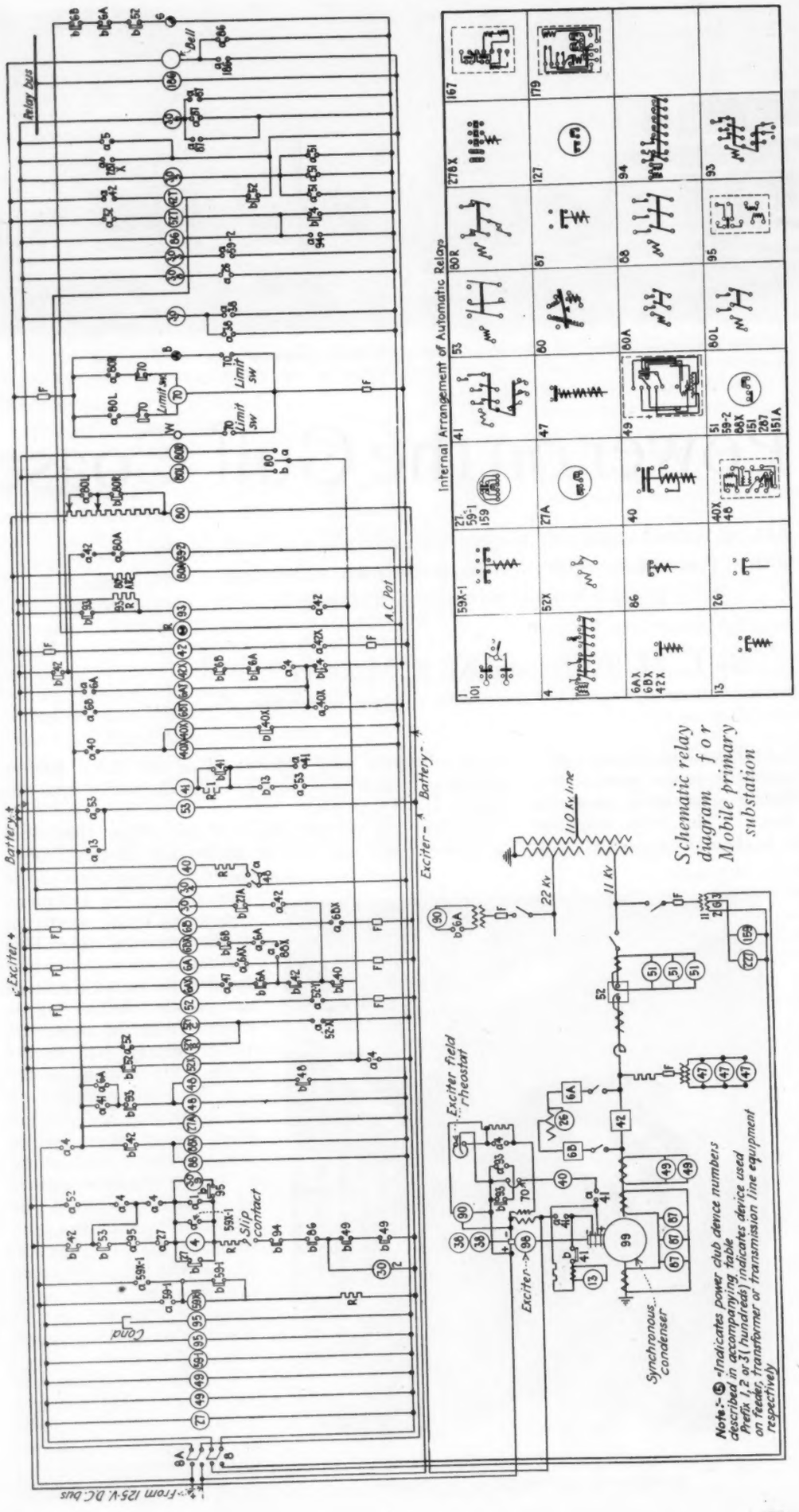
For more than twelve months previous to the above-chronicled event engineering studies had been complete and construction crews had been at work on the 187-mile, 110-kv. transmission line between Mobile and the Lock 18 substation of the Alabama Power Company. For a somewhat shorter time construction work had been in progress on the new 18,000-kva. primary substation near Mobile and on the 22-kv. feeders radiating from it to serve a growing district of approximately 150,000 people.



Voltage on 187-mile, 110-kv. line regulated by 10,000-kva. synchronous condenser

Of the many various phases of this project that could be treated only one will be undertaken at this time—namely, a description of the operation of the automatic equipment in the substation at the receiving end. This substation, on account of its importance to such a large and growing district, far removed from the source of power supply, had to include in its make-up provision for voltage control of the long line as well as every practicable device available that would insure to the city the same quality of service to which its neighbors up state had been accustomed. The selection of equipment, particularly that involved in the automatic operation of the substation, was therefore made with especial care.

If frequent reference is made to the elementary and schematic relay diagrams given herewith, the operation of this automatic equipment can be more readily



understood. All devices are shown in their normal or de-energized position and auxiliary switches and contacts are marked *a* if open and *b* if closed when in normal open or de-energized position. The elementary diagram is for the automatic features of the synchronous condenser only, whereas the schematic relay diagram shows in full the wiring for the protection of and for the automatic features of the entire station except the condenser. All devices are referred to by standard power club numbers used by the Alabama Power Company and are completely described in the accompanying table.

The purpose of this automatic switching equipment is to start the 10,000-kva., 11,000-volt synchronous condenser and connect it to the line if conditions warrant; to reclose automatically the four outgoing 22-kv. feeder breakers when they trip with normal conditions on the 22-kv. buses; and to protect against abnormal conditions that might cause serious trouble. The operation of the condenser is entirely automatic after the pull-button switch is closed to release the equipment for operation, and this switch remains in the closed position until it is opened manually to take the machine out of service.

The condenser is started as an induction motor on reduced voltage from a starting auto-transformer, the condenser field being short circuited through a resistance during the starting period. Just as the machine reaches synchronous speed and the exciter voltage builds up, the starting

Devices and Relays Used in the Mobile Substation by the Alabama Power Company

The key numbers given in the first column coincide with those used in text and on diagrams.

No.	Type	Description	No.	Type	Description	No.	Type	Description
1	.....	Master element	42X	PB-54	Hesitating control relay for 42	87	PQ-6Y	Differential current relay hand reset
4	CR-2800	Master contactor	42T	.....	Running breaker trip coil	88	CR-2810	Oil pump motor contactor
5	.....	Emergency tripping switch	47	PI-3	Single or reverse phase voltage relay	88X	IA-204-Y7	Auxiliary relay for 88
6A	FKR-132-A	Magnetising oil-circuit breaker	48	MC-10	Starting protective relay	90	TA-T8	Voltage regulator
6AX	PB-54	Hesitating control relay for 6*A*	49	TC-213D	Alternating-current thermal relay	93	CR-2810	Field-changing contactor
6AT	.....	Magnetising breaker trip coil	51	IA-201	Alternating-current overcurrent relay	94	CR-2800	Tripping contactor
6B	FKR-132-A	Starting oil-circuit breaker	52	O-221	Line oil-circuit breaker	95	IJ-8Y1	Underfrequency relay
6BX	PB-54	Hesitating control relay for 6*B*	52X	CR-2820	Hesitating control relay for 52	98	Allis	Condenser exciter
6BT	.....	Starting breaker trip coil	52Y	S	Trip free control relay for 52	99	Allis	Synchronous condenser
8	LP-1	Alternating-current control power switch	52T	.....	Line breaker trip coil	127*	IA-204Y3	Alternating-current undervoltage relay
8A	LP-1	Direct-current control power switch	53	CR-2800	Exciter relay	159*	IA-204Y3	Alternating-current overvoltage relay
11	.....	Control power transformer	59-1	IA-204Y3	Alternating-current overvoltage relay	167*	IB-1	Reverse power relay
13	PQ-33	Synchronous speed device	59X-1	PQ-25Y5	Auxiliary relay for 59-1.	179*	MD-2	Automatic reclosing relay
26	TB-2	Compensator thermal relay hand reset	59-2	IA-204Y3	Alternating-current overvoltage relay	186*	PQ-6	Bell alarm relay hand reset
27	IA-204Y3	Alternating-current undervoltage relay	70	CR-8422	Motor-operated field rheostat	287*	IA-201	Transformer bank differential relay
27A	IA-204Y3	Alternating-current undervoltage relay	80	TR-W-1B	Direct-current undervoltage relay	287X*	PB-58	Auxiliary relay for 287
30	Edwards	Annunciator	80A	PQ	Direct-current undervoltage relay	227*	IA-204	Alternating-current undervoltage relay
38	Foxboro	Bearing thermal relay	80L	CR-2800	Auxiliary relay for 80			
40	PB-55	Alternating-current machine field relay	80R	CR-2800	Auxiliary relay for 80			
40X	MC-10	Auxiliary relay for 40	86	PQ-6Y	Current locking out relay hand reset			
41	CR-2810	Field contactor						
42	FKR-132-B	Running oil-circuit breaker						

* The prefix 1 to any device number indicates that the device is used on feeder equipment, and prefix 2 indicates its use on transformer equipment.

breakers are tripped and the running breaker is closed, connecting the condenser on full-line voltage. The short circuit is then removed from the condenser field and the field is connected direct to the exciter. The field resistance is then automatically adjusted to normal value and field current is applied as conditions warrant. If abnormal conditions arise at any time during the operation of the condenser, it will be shut down by some one or more of the protective devices described later.

The outgoing feeder breakers are first closed manually by pull-button control switches, and they may also be tripped by these switches. After automatic tripping of any of the feeders under normal conditions, the breaker will be reclosed three times and then locked out until the reclosing device for that breaker is reset manually, unless the breaker remains closed after one of the reclosures. In the latter case the reclosing device will reset automatically. This device for any breaker may be made inoperative at any time by opening a knife switch on the control panel.

With the foregoing explanation of the purpose of the automatic equipment a detailed description of the operations under normal and abnormal conditions will follow:

Normal Operation

For normal operation, with all circuit breakers open and all protective devices reset, the 110-kv. line breaker is closed, energizing the 18,000-kva. transformer bank. Control switches 8 and 8*A* are then closed, energizing the 220-volt alternating-current control bus from the 2½-kva. power transformer 11, and the 125-volt direct-current control bus from the storage battery. If the alternating-current line voltage and frequency are normal, devices 27 and 95 close their *a* contacts and open their *b* contacts, and the condenser is ready to start.

The condenser is then released for automatic operation by closing pull-button switch 1. This energizes the coil of the master contactor, device 4, from the battery bus through the contacts of protective relays and *b* contacts of exciter relay 53 and running breaker 42, indicating that normal conditions exist, that there is no current in the field and that condenser is not connected to the line. Device 4 then closes its *a* contacts, energizing 27*A*; also 88, which starts the oil pressure pump for the condenser bearings; 88*X*, which starts to close its contacts; 48, which starts timing action, and 52*X*, which closes 52*Y*, which in turn closes 52. The closing of line breaker 52 makes a holding circuit for device 4, de-energizes 42*X* and 42*Y*, energizes condenser potential transformers and device 47. Voltage being normal, 6*AX* is energized through 47, *b* contacts of 6*A*, 40 and 42 closing 6*A*, which

Summary of Major Equipment Used in Mobile Step-Down Substation

Equipment	No.	Manufacturer	Type	Remarks
Power transformers				
6,000 kva., 110/22/11 kv	4	Allis-Chalmers	O.I.W.C.	Capacity of each tertiary winding, 3,333 kva.
Station service transformer				
75 kva., 22 kv/230/115 volt	3	General Electric	O.I.S.C.	For station auxiliaries
Outdoor potential transformers				
500 va., 22 kv./110 volt	1	General Electric	O.I.S.C.	For regulator
200 va., 22 kv./110 volt	4	General Electric	O.I.S.C.	For metering and synchronising
Outdoor current transformers				
25-kv.-600/5 amp	2	General Electric	K-202	For metering
110-kv. oil-circuit breakers	1	General Electric	FHKO-36-115B	Interrupting capacity 500,000 kva.
25-kv. oil-circuit breakers	7	Westinghouse	O-221	Interrupting capacity 455,000 kva.
22-kv. lightning arresters	4	General Electric	Oxide Film	.....
Synchronous condenser				
10,000 kva., 11 kv, three-phase, 60 cycle	1	Allis-Chalmers	.....	Operates from tertiary of power transformers
Switchboard				
14 panel, 1¼-in. slate	1	General Electric	24x90 in.	Includes automatic equipment for condenser
Carrier current equipment	1	Westinghouse	.....	250 watt
Circulating-water pumps				
300 g.p.m. 70-ft. head	2	Allis-Chalmers	SH	For transformers and condenser
110-kv. disconnecting switches				
400-amp. upright mounted	1	Southern States Equipment	VGL	For bypass on 110-kv. breaker
400-amp. underhung mounted	2	Southern States Equipment	M	.....
22-kv. disconnecting switches				
400-amp. upright mounted	24	Southern States Equipment	"57"	Breaker disconnecting switches
400-amp. horizontal mounted	5	Southern States Equipment	"57"	O. C. B. bypass switches
22-kv. fuses	14	Schweitzer & Conrad	D	For potential and service transformers
Insulators				
110-kv. post	27	Jeffery-Dewitt	A-254; A-258	7 unit
22-kv. post	126	Delta Star	DZO and ZDO	Post type
11-kv. post	43	Delta Star	DK	Cat. No. 12590
Disk insulators	283	Ohio Brass	No. 25622	.....
Traveling crane	1	Whiting	.....	30 ton
Storage battery	1	Electric Storage Battery Co.	MVJ-9	60 cells

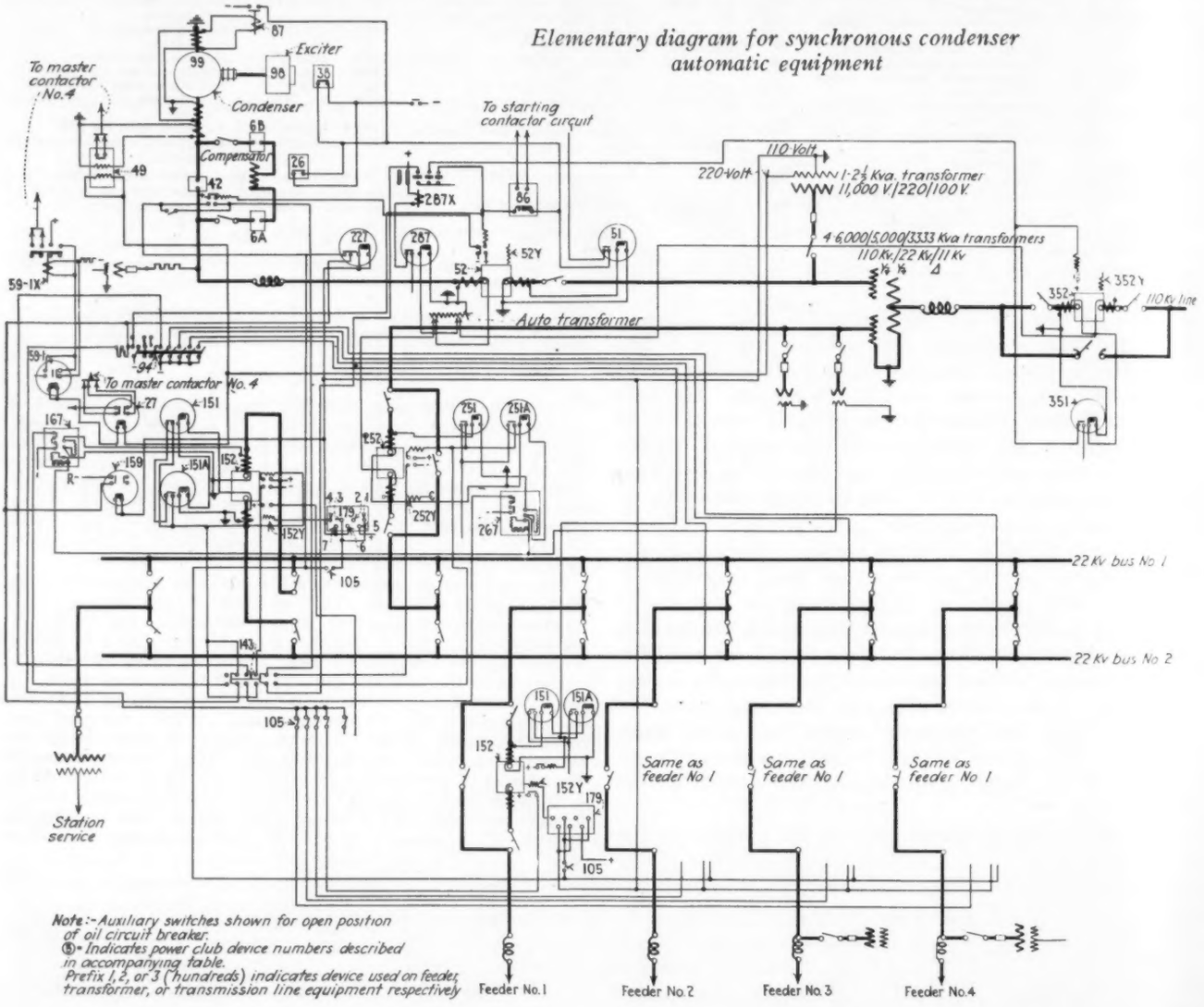
energizes the condenser-starting compensator. After a time delay 88*X* has closed its contacts, which energizes 6*BX* when 6*A* reaches its closed position, starting the condenser 99 to rotating.

The starting of 99 induces a heavy current in its field, causing synchronous speed device 13 to close its *a* contacts and closing the circuit to coil of 53 to the exciter leads. As 99 approaches synchronous speed the exciter voltage builds up to such extent as to operate the exciter relay and the current dies down in the field, allowing 13 to drop back, opening its *a* and closing its *b* contacts. The exciter relay 53 forms a holding circuit for its coil and with *b* contact of 13 energizes the coil of the field contactor 41. The closing of 41 removes the short-circuiting discharge resistor from the condenser field and connects the field to the exciter through high resistance, allowing sufficient current to flow to operate the field relay 40 with the aid of the potential winding. The closing of 40 breaks the closing circuit to breakers 6*A* and 6*B*, and closes timing relay 40*X*. The holding coil of 40*X* remains energized, but after a time delay opens its motor circuit and closes a circuit to the trip coils of 6*A* and 6*B*, and sets up closing circuit to the control relay 42*X*. When 6*A* and 6*B* trip, 42*X* is energized, closing the condenser running breaker 42, which connects the condenser on full-line voltage. Device 93 is then energized, which in turn closes its contacts, shunting out the high resistance in the field and allowing the voltage to build up to normal value. The condenser is now connected to the line and under the control of the voltage regulator, since the opening of the magnetizing breaker 6*A* closes the alternating-current potential circuit to the coil of regulator 90 through *b* contacts of 6*A*. If now the line voltage is too high, the contacts of 90 open, inserting resistance in the exciter field, which in turn decreases the condenser field, causing the condenser to operate at lagging power factor. Below a certain voltage the exciter operation becomes unstable, and to enable it to operate at a more efficient point direct-current undervoltage relay 80 drops out, closing its *a* contacts and closing circuit to the coils of 80*R*, which in turn operates the motor of the main field rheostat 70, cutting resistance into the condenser field, causing the condenser to operate at a still lower power factor. Regulator 90 then cuts resistance out of exciter field, allowing exciter voltage to return to a normal value. Device 80 then opens its *a* contacts, de-energizing 80*R*.

If the line voltage is too low, the regulator 90 increases the exciter field, causing the condenser to operate at leading power factor. If the exciter voltage should become too high, undervoltage relay 80 closes its *b* contact, energizing 80*L*, causing the motor-operated rheostat to decrease the resistance in the condenser field. The regulator 90 then brings exciter voltage down to normal, and 80 opens its *b* contact, de-energizing 80*L*.

With the condenser now on the line and the 22-kv. bus voltage normal, the control switches for the four feeder breakers are operated manually, closing these breakers, 152, through a circuit to 152*Y*. The control switches also set up circuits to the four reclosing relays 179, which circuits remain made until the control switches are operated to the trip position.

Elementary diagram for synchronous condenser automatic equipment


To master contactor No.4
Exciter
Condenser
Compensator
To starting contactor circuit
110 Volt
220 Volt
1-2½ Kva. transformer 11,000 V/220/100 V.
4 6,000/5,000/3333 Kva transformers 110 Kv./22 Kv./11 Kv.
Auto transformer
110 Kv. line
To master contactor No. 4
22 Kv. bus No. 1
22 Kv. bus No. 2
Station service
Same as feeder No. 1
Same as feeder No. 1
Same as feeder No. 1
Feeder No. 1
Feeder No. 2
Feeder No. 3
Feeder No. 4
Note:- Auxiliary switches shown for open position of oil circuit breaker.
Indicates power club device numbers described in accompanying table.
Prefix 1, 2, or 3 (hundreds) indicates device used on feeder, transformer, or transmission line equipment respectively

Abnormal Operation

This automatic equipment provides protection against abnormal operations, which are divided into two classes:

1. Transient troubles for which the condenser is shut down temporarily and prevented from restarting until normal conditions are restored:
   - (*a*) Undervoltage on bus.
   - (*b*) Overvoltage on bus.
   - (*c*) Reverse power through the transformer bank.
   - (*d*) Overheating of stator windings.
   - (*e*) Underfrequency.
   - (*f*) Overload on feeders.
2. Serious troubles which prevent resumption of opera-

tion until equipment is inspected and devices reset by hand:

(*a*) Failure of transformer windings.
(*b*) Failure of condenser windings.
(*c*) Overheating of condenser bearings.
(*d*) Incomplete start of condenser.
(*e*) Overheating of starting compensator.
(*f*) Overload on the condenser.

These operations will now be described in more detail.

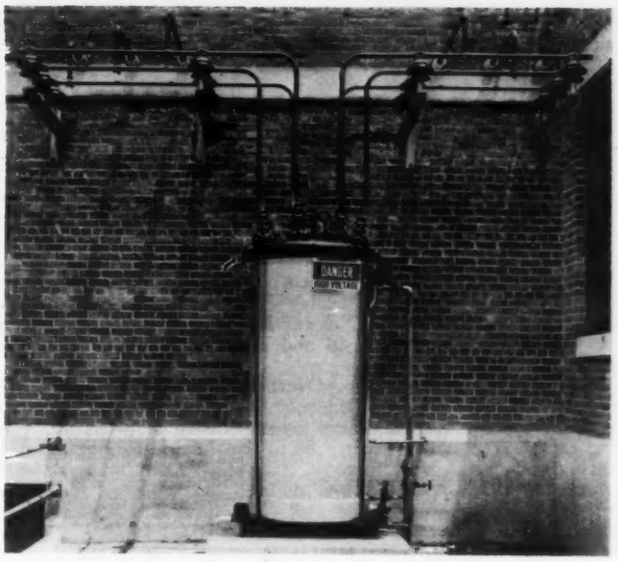
Temporary Shutdowns

Undervoltage.—With undervoltage on the alternating-current bus, relay 227 closes its *a* contacts, closing the circuit to the coil of tripping contactor 94, which in turn trips breakers 52, 152 and the bus tie breaker if the latter is operating as a feeder breaker. Upon tripping of these breakers by relay 227, relay 27 opens its *a* contact, which prevents the condenser restarting until normal voltage is restored. When this occurs, 27 closes its *a* contact, starting the condenser, which, as previously described, is then connected direct to the line by breaker 42. Reclosing relays 179 then close feeder breakers 152, also the bus tie breaker if operating as a feeder breaker.

Overvoltage.—If excessive voltage conditions occur with the condenser in operation, overvoltage relay 159 closes its contact, energizing contactor 94, which trips the feeder breakers and 52. At the same time 59-1 closes its *a* contact and opens its *b* contacts, energizing coils of 59*X*-1, which shunts out coil of 4 and holds it out until normal voltage is restored. When this occurs, 59-1 closes its *b* contact, allowing 59-*X*-1 to open its *a* contact so that the condenser restarts and the feeder breakers 152 reclose directly after the condenser is connected to the line.

Reverse Power.—When any of the feeders are connected to the local steam plant and that plant is generating, the reclosing features of 152 are made inoperative by opening a knife switch on the front of the switchboard. For trouble on the 110-kv. line the steam plant contributes to the trouble and causes reverse power to flow through breaker 252. This reversal of power causes relay 267 to operate, energizing the coil of 94, which trips the 22-kv. feeder breakers and the condenser breaker. When alternating-current voltage is restored on the transformer bank, the condenser restarts automatically, but the feeders must be synchronized by hand, as the reclosing scheme is inoperative due to the operation of the steam plant.

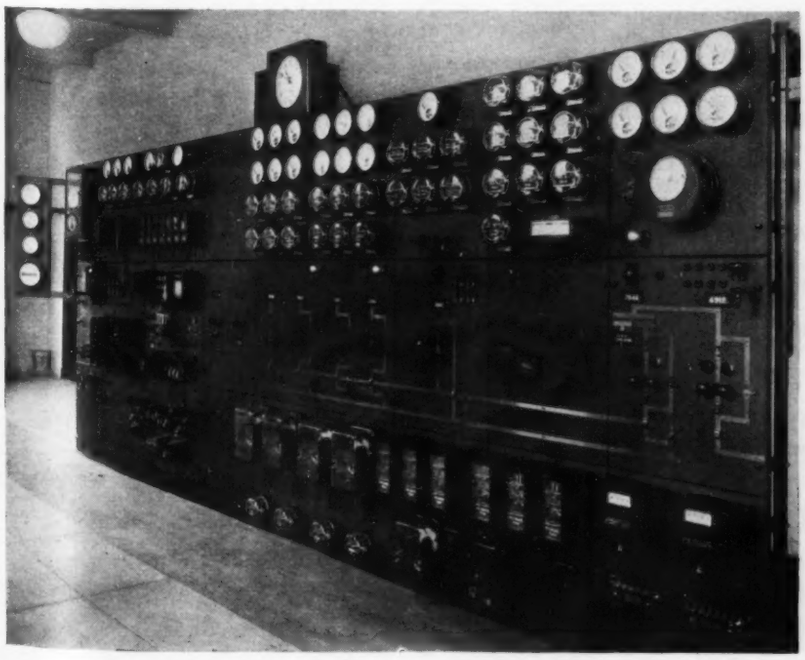
Overheating of Stator Windings.—For the protection of the stator windings against overheating, thermal relay 49 contains an element with the same heating characteristics as stator windings, so that when current flowing through these windings reaches an excessive value and continues for a period sufficient to cause overheating, 49 opens its *b* contacts, which de-energizes 4 and holds it out until the thermal element has cooled to such a value as to allow its *b* contacts to close again. Tripping or opening of the *b* contacts also causes the annunciator to operate.

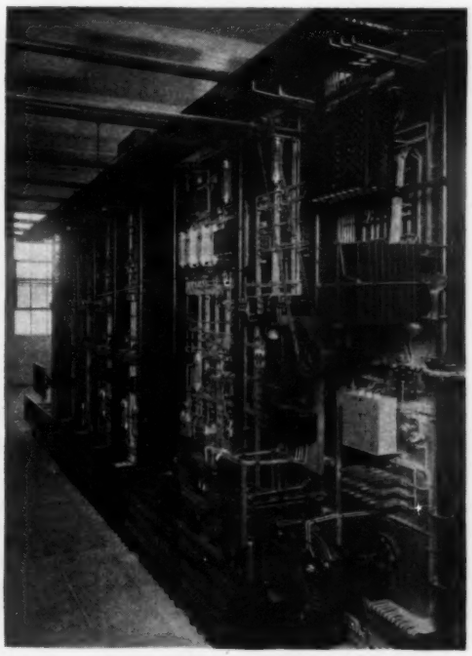


Starting auto-transformer for 10,000-*kva. synchronous condenser*

Underfrequency.—When the system frequency drops to 5 per cent below normal, relay 95 closes its *b* contacts and opens its *a* contact, the former shunting out coil of 4 and operating the annunciator; 4 prevents restarting the condenser until the frequency is restored to normal.

Overload on Feeders.—Should an overload develop on any feeder, its breaker opens due to action of overcurrent relay 151 or ground relay 151*A*. The *b* auxiliary switch of breaker 152 then closes a circuit to 179*X*, which completes the circuit to the release coil of reclosing relay 179, which allows its armature to rotate. After one minute the first arm of this relay closes its front contact, closing an auxiliary relay, which seals itself in. The back contact is then closed by the first arm, which recloses breaker 152 through 152*Y*. If 152 remains closed, the operating disk of 179 makes a complete revolution and resets itself for a new cycle, but if the breaker reopens within one minute, the second arm of 179 repeats the action of the first arm. If the feeder is still subjected to overload, 152 again trips and is reclosed for a third time by the third and last arm of 179. If after the third reclosure overload still persists, 152 again trips and closes its *b* switch. In this case there will be no reclosure, for after one revolution of the disk of 179, if the release coil is still energized, a stop arm engages the disk and holds it in the lock-out





The switchboard in Mobile substation is compact and neat, as indicated in front and rear views

position until 179 is reset by hand. If, however, 152 remains closed after either the second or the third reclosure, 179 returns to the reset position ready to begin a new cycle.

Permanent Shutdowns

Failure of Transformer Windings.—Upon failure of the power transformer windings a differential current flows in the leads from the high-tension and low-tension windings, causing relay 287 to close its contacts, operating 287*X*, which trips breakers 252, 352 and 52 and operates relay 86, locking out the condenser and giving an alarm to the operator.

Failure of Condenser Windings.—Failure of the condenser windings causes a differential current to flow between the condenser bus and the neutral leads. This current operates machine differential relay 87, which closes its *a* contact, tripping breaker 52 through lock-out relay 86 and giving an alarm through annunciator 30.

Overheating of Bearings.—Overheating of the condenser bearings causes the dial type thermometer 38 to close its contacts, which are set at the maximum safe operating temperature. Closing of these contacts operates 86 to trip 52 and to give an alarm through 30.

Incomplete Starting.—When the starting sequence is initiated, the magnetizing breaker 6*A* closes, energizing the starting protective relay 48, which starts a timing action. If after a definite time delay sufficient for the machine to come up to speed and be connected direct to line the *b* contact of 93 has not opened, deenergizing 48 and stopping the timing action, the delay contact closes, operating 86 to trip and lock out 52 and give alarm.

Field Failure.—Two methods are provided for shutting down the condenser in case its excitation is lost. With high alternating-current voltage loss of excitation causes relay 59-2 to operate through interlocks on 42 and 4 so that, if excessive voltage exists on the bus with machine in running position and exciter potential fails, 59-2 operates 86 to trip and lock out 52 and give an alarm.

With low alternating-current voltage loss of excitation with the machine in the running position causes 27*A* to be energized from the alternating-current bus through the *a* contact of 4. If the alternating-current voltage is low, allowing 27*A* to close its *a* contacts and the field current to drop low enough to allow the *b* contact of field relay 40 to close its *b* contact, a circuit is completed through these contacts and the *a* contacts of 4 and 42 operating relay 86 to trip and lock out 52 and give an alarm.

Overheating of Compensator.—With overheating of the starting compensator, the liquid in bulb of thermal relay 26, which is inserted in the compensator, expands with an increase in temperature, closing the relay contacts, operating 86 to trip and lock out 52.

Condenser Overload.—When an overload occurs on the condenser, overcurrent relay 51 operates 86 to trip and lock out 52.

Each and every one of the foregoing conditions was carefully worked out between the engineers of the company and the engineers of the General Electric Company, with the result that perfect operation resulted during the six months that the equipment has been in service.

Operating Experience With Rectifiers

RESULTS obtained by the Chicago, North Shore & Milwaukee Railroad in operating mercury-arc rectifiers are presented below. Most of the data cover an entire year's experience and were presented by Caesar Antoniono, electrical engineer of the company, at the Chicago meeting of the A.I.E.E.

Table I—Performance of Rectifier and Synchronous Converter Substations

The kilowatt and efficiency values do not include the power used for the operation of automatic devices in auxiliaries such as vacuum pump, water pump, motor-generator set and heaters in the rectifier station nor the power used for auxiliaries and alternating-current contactors in the converter stations

Substation	No. 1	No. 2	No. 3	No. 4	Liberty	No. 5
Type Machine	Converter	Converter	Converter	Converter	Lake Converter	Rectifier
Rating, Kilowatts	1,500	1,500	1,500	1,500	1,000	1,000
May, 1927						
Total alternating current input, kilowatt-hours	87,300	43,500	69,600	125,700	115,950	89,700
Total direct current output, kilowatt-hours	62,130	30,550	53,200	97,900	83,154	71,952
Total hours run	341	201	310	434	496	403
Average hours per day	11	6.5	10	14	16	13
Average kilowatt-hours per hour	182	151	171	225	167	178
Efficiency, per cent	71.2	70.2	76.5	78	71.8	80
June, 1927						
Total alternating current input, kilowatt-hours	86,800	34,200	74,400	84,300	139,950	75,900
Total direct current output, kilowatt-hours	59,024	23,214	58,200	62,400	105,844	62,857
Total hours run	300	180	330	315	660	270
Average hours per day	10	6	11	10.5	22	9
Average kilowatt-hours per hour	130	128	176	197	160	232
Efficiency, per cent	68	67.8	78.3	74	75.6	82.8
July, 1927						
Total alternating current input, kilowatt-hours	82,200	34,200	78,300	95,700	146,100	79,950
Total direct current output, kilowatt-hours	57,140	25,294	60,800	73,000	104,263	65,747
Total hours run	341	201	341	372	715	387.5
Average hours per day	11	6.5	11	12	23	12.5
Average kilowatt-hours per hour	167	125	178	196	131	170
Efficiency, per cent	69.5	73.7	77.6	76.3	71.3	82.2
August, 1927						
Total alternating current input, kilowatt-hours	95,700	32,100	104,400	84,600	119,250	70,215
Total direct current output, kilowatt-hours	69,770	21,133	83,200	65,800	88,246	56,721
Total hours run	403	186	372	310	434	341
Average hours per day	13	6	12	10	14	11
Average kilowatt-hours per hour	173	113	223	212	203	166
Efficiency, per cent	72.9	65.8	79.7	77.8	73.1	80.7
September, 1927						
Total alternating current input, kilowatt-hours	84,300	50,220	95,370	83,040	118,740	83,460
Total direct current, output, kilowatt-hours	61,190	33,197	75,300	62,300	88,731	67,868
Total hours run	330	240	360	285	525	420
Average hours per day	11	8	12	9.5	17.5	14
September, 1927 (Continued)						
Average kilowatt-hours per hour	185	138	209	218	169	161
Efficiency, per cent	72.6	66.1	78.9	75.0	74.7	81.3
Average efficiency of each substation, per cent	70.8	68.7	78.2	76.3	73.3	81.7
Average kilowatt-hours per hour	167.4	131	191.5	209.2	166	181.4
Grand average, efficiency, per cent			73.4			81.7

TABLE II—RECORD OF SHUT-DOWNS OF RECTIFIER FROM MAY, 1926, TO MAY, 1927

Cause of Shut-down	No.	Total Time Minutes
High temperature of tanks	2	48
Exciter trouble	39	536
Driving chain and motor on water pump	13	315
Loose connection and bad control circuit	3	50
Vacuum-pump trouble, motor and oil pump	3	260
Flashover of anodes	6	819
Starting anodes sticking	5	602
Miscellaneous unknown	12	1,109
Total shut-downs	83	3,739

Total time rectifier operated 337,140 minutes.

Shut-down by failure of	No. of Times	Average Time Minutes	Per Cent of Time of Operation
Rectifier	25	58	0.435
Auxiliaries	58	39	0.674
All	83	45	1.109

TABLE III—RECORD OF FAILURES SINCE MAY, 1927, WHEN SUBSTATION WAS MADE AUTOMATIC

Failure in auxiliary	No. of Shut-downs
Motor on one vacuum pump burned out	1
Locked out after third reclosing of the oil circuit breaker within a definite time during storms	3
Locked out on account of broken spring on oil-switch mechanical latch	3
Locked out after third reclosing of the oil circuit breaker within a definite time, cause unknown	5
Fuse blown on operating transformer supplying power for the operation of devices	1
Total shut-downs	13

Simplified

Distribution Planning*

Relations between transformer spacing, energy loss and voltage drop developed for equations of economical transformer and conductor sizes

By W. R. BULLARD
Electric Bond & Share Company, New York City

IN CONSIDERING the characteristics of the secondary distribution system, where the conductors are arranged in straight line feeds without branches, the well-known relations between transformer spacing, energy loss and voltage drop are used in the development of simplified equations which can be used in determining economical transformer and conductor sizes to fit any given set of local conditions.

SECONDARY SYSTEM

Much has been written concerning the comparative merits of various voltage combinations in secondary distribution systems, such as three-wire single-phase for lighting, separate three-wire three-phase for power, four-wire three-phase for power and lighting, etc.

Therefore in this article no comparison is made between the different types of systems. However, in so far as possible, the methods and formulas have been made sufficiently general to apply to all the usual types of secondary systems.

General Scheme of Design.—As mentioned previously, there are two types of loads that should be considered separately in the design of the distribution system—namely, the general distributed load of the system as a whole, and individual loads of large sizes. Loads of the latter type are usually served individually by special transformer banks not connected to the secondary mains, or else by transformers of extra large size connected to the secondary mains, but located immediately adjacent to the concentrated load which they serve. Thus in designing the secondary system large concentrated loads need not be considered in connection with the selection of copper sizes, etc., since in general the current of these loads does not pass through the secondary mains.

In the selection of copper sizes and transformer sizes for the distribution system, exact calculations of the economics are not practicable, due to a number of indeterminate factors and to the fact that the exact characteristics and distribution of the load cannot be conveniently determined either for the present or for the future. However, by making a reasonable number of simplifying assumptions and by considering average conditions in different sections of the system, average sizes can be established for low-voltage copper and distribution transformers to serve the load economically.

In establishing average characteristics of the load it is, of course, not permissible to consider the entire system in one set of calculations unless the system should be comparatively small or unless conditions should be comparatively uniform throughout. However, in most cases it is possible to select a few sections of territory in any given system throughout each of which all the determining factors will be fairly uniform. In a medium-sized town, for instance, there is usually a business section where the load is fairly concentrated and of certain particular characteristics; a high-class residential district in which the load characteristics are different from those in the business section, but nevertheless fairly uniform, and a poorer class of residential section in which the load characteristics are different from those of the two other sections.

SIZE OF TRANSFORMERS AND CONDUCTORS

A practical procedure for establishing proper sizes of transformers and secondary copper in average distribution systems is to consider separately each of two or three different districts, such as those mentioned, and to make complete calculations in each case to fix the proper characteristics.

The calculations should be based on load conditions that will exist several years in the future. Thus if transformer sizes and copper sizes determined from the method that is to be described are adopted immediately, these sizes will be somewhat larger than those theoretically correct for existing conditions, but the proper economics will be approached during the growth of load for several years until the most economical point is reached, after which the cost will again gradually exceed the theoretical minimum, but at no time during a number of years of system growth will the over-all cost be greatly different from the theoretical minimum.

After the proper copper sizes have been determined, these sizes will of course be used for extensions and replacements of secondary mains in the particular sections to which the different sizes apply. The transformer sizes determined by the economics will, of course, be used in average cases in the particular sections to which they apply, although a small proportion of other sizes can be used when required. After a number of years have passed it is, of course, desirable to make a new study of the system economics and revise the values previously obtained. The new values can then be used for extenions and replacements of the old system.

**The first article of this series appeared in* ELECTRICAL WORLD *March 10, 1928. The third article will be published in an early issue.*

If, instead of increasing the transformer sizes with the growth of load, as is frequently done in the operation of distribution systems, the economical size of transformers be adhered to in all average cases and the growth of load be handled by setting new transformers of the same size at intermediate points between the old transformers, the growth of load can be handled indefinitely with the same secondary copper and with a gradually decreasing voltage drop and decreasing percentage of secondary copper loss.

It is not necessary, of course, to have a decreasing voltage drop or copper loss if the design of the system has fixed the proper values of these quantities at the start. In some measure, therefore, it is desirable to use at the start transformers somewhat smaller than those indicated by the calculations, gradually increasing the size until after a number of years, these sizes may be somewhat larger than the values indicated by the study. The tendency should be, however, toward the establishment of a more or less fixed standard of sizes and toward handling the growth of load by setting new transformers rather than replacing old transformers with new ones of larger size.

Straight Line Feeds

In the following discussion the term "network feed" is used to indicate that each transformer feeds a portion of a system the secondary mains of which have a network arrangement formed by intersecting streets. The portions served by individual transformers may either be separated from each other, as in the case of a radial system, or may be interconnected to form a large network, as in the case of the so-called low-voltage multiple-feed network system.

The laws governing voltage drop and power loss in a circuit consisting of a single line without branches are well known. Where the low-voltage system consists of such a line, the load being uniformly distributed and the transformers being of equal size and uniform spacing, both the voltage drop and power loss are inversely proportional to the square of the number of transformers or directly proportional to the square of the size of each transformer.

Let I_T equal the load current per leg of the transformer; a equal the area of cross-section of each conductor of secondary mains in units of 1,000 circ.mil; V equal the maximum voltage drop per conductor in volts; W equal power loss in kilowatts per 100 ft. of single conductor; D equal load density in amperes per conductor per 100 ft. of circuit. Then, if each transformer feeds current equally in each direction in the secondary mains,

$$V = \frac{0.137\, I_T^2}{Da}$$

$$W = \frac{0.0915\, I_T^2}{1{,}000\, a}$$

These two equations give volts drop and power loss per conductor in terms of the load at each transformer, load density and cross-section of copper.

In practice it is not always possible to have the transformers so spaced that the load will be equally divided between them, nor for any given section of secondary mains is it always possible to have the transformer in the exact center of the load. Therefore, due to these difficulties and due to variations in load density and variations in other system characteristics, the values of voltage drop and power loss would in practice be considerably higher than those given by the above equations.

In order to make the equations applicable to average conditions of practice in the majority of small- and medium-sized systems, the values of voltage drop and power loss should be increased about 100 per cent, which gives

$$V = \frac{0.274\, I_T^2}{Da} \qquad (1)$$

$$W = \frac{0.183\, I_T^2}{1{,}000\, a} \qquad (2)$$

The value of 100 per cent may seem at first sight to be a large proportionate increase in the constants of the equations to care for departures in practice from balanced and uniform conditions. However, when it is realized that an off-center spacing of only 25 per cent of the total length of line served by one transformer (three times as much load in one direction as in the other) will give 225 per cent of the theoretical voltage drop and 175 per cent of the theoretical power loss for perfectly balanced conditions, it can be seen that the increase of 100 per cent is a reasonable allowance for average systems in which it is not possible to maintain specialized organizations constantly to check and correct unbalanced conditions. Whereas the effect of the transformer being off center is to increase the voltage drop more than the power loss, the effect of the load being non-uniformly distributed is to increase the power loss more than the voltage drop. In practice, therefore, there is likely to be a similar increase of both quantities.

In large, thoroughly organized systems it will usually be possible to hold the values nearer to those corresponding to ideal conditions. The application of the equations given in this article to a case of this kind can be very easily corrected by increasing the value of the allowable voltage drop and decreasing the estimated unit cost of energy loss before these values are inserted in the equations. Probably in the largest and best organized systems an allowance of 50 per cent instead of 100 per cent could be made in deriving equations 1 and 2. In this case, to make the equations of economics given in the last part of this series applicable, the allowable voltage drop as estimated from service conditions should be multiplied by the factor $\frac{4}{3}$ and the unit cost of copper losses where applied to secondary mains should be multiplied by the factor $\frac{3}{4}$.

The equation for voltage drop is calculated on the basis of resistance drop only. However, in usual types of distribution systems, the power factor at the peak of the load is high, due to the high percentage of lighting load. Therefore the maximum voltage drop will usually only slightly exceed the theoretical values calculated for resistance only. A small amount of additional voltage drop due to the effect of the line reactance will usually be taken care of by the factor of safety used in equation 1.

Where the conductors are small and are spaced reasonably close together, the resistance is usually the dominating part of the impedance. Where the conductors are large and are separated by an appreciable distance, as for instance in the case of large single-conductor underground cables located in separate ducts, the reactance may be the dominating part of the impedance. In such cases, if the power factor of the load happens to be low, appreciable errors may be introduced into the calculations of economics by the fact that reactance has been neglected. However, even in such cases, the equations may be used to obtain a first approximation to the correct results, the

figures obtained being then checked by actual calculation of voltage drop. If the error is shown to be appreciable by this method, very nearly correct results can be obtained by making a second set of calculations, using a value for allowable voltage drop, less than the actual value in proportion to the amount that the allowable value has been exceeded by the results of the first set of calculations.

Economical Transformer Spacing and Copper Size.—Upon applying certain simplifying processes the calculation of economical transformer spacing and copper size become a comparatively simple matter by the use of the

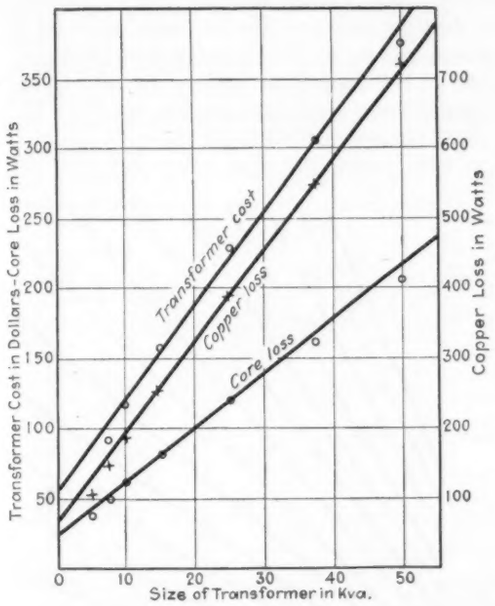


Fig. 1—Cost and losses of 2,300-volt distribution transformers, single phase, 60 cycle

above equations for power loss and voltage drop. Take first the case of a simple straight line circuit. Factors that enter into the calculations of economics are, cost of power loss in transformers and fixed charges on transformer investment, cost of power loss in secondary mains and fixed charges on investment in secondary copper.

If the investment costs of transformers are plotted against transformer sizes, the result is approximately a straight line for a limited range of transformer sizes. (See Fig. 1.) The point where this line cuts the axis of cost represents a cost that applies to each transformer regardless of its capacity. The slope of the line represents the cost per kilovolt-ampere capacity for any given number of transformers. Since the kilovolt-ampere capacity of any given system is fixed, this latter cost is fixed and therefore has no effect in determining the economics of transformer spacing. The fixed cost per transformer mentioned above, however, is a very useful quantity. If we take this cost and add to it the cost of installation, including auxiliary devices such as fuses, lightning arresters, ground connections, etc. (in the case of an underground system the cost of the transformer vault would be included), the result is a total fixed cost per transformer installation. This multiplied by a percentage figure to reduce it to fixed charges per annum gives an expression that can be used directly in computing the economics.

To this quantity, however, should be added the yearly cost of the fixed part of transformer losses. The latter can be obtained in the same manner as above by plotting losses against size of transformer (see Fig. 1) and using the values where the lines cut the axis of losses. In plotting the copper loss curve of Fig. 1 the values should correspond to the transformer loading that will be used in practice. For instance, if in order to obtain good economy it is desired to load transformers on the average of, say, 115 per cent of their rating at the system peak load, then the copper loss at 115 per cent load should be used in plotting the copper loss curve. In order to obtain the annual cost of core loss it is necessary to multiply by the total number of hours in the year, whereas in the case of copper loss the annual duration factor previously described must be used.

Let C_1 equal total yearly transformer costs per installation exclusive of the costs which vary with the size of transformer; W_1 equal copper loss in kilowatts per transformer installation taken from curves similar to those in Fig. 1; W_2 equal core loss in kilowatts per transformer installation; C equal cost of copper loss in dollars per kilowatt-hour; C_4 equal the cost of core loss in dollars per kilowatt-hour; C_5 equal fixed charges on cost of each transformer installation including the intersecting point of the cost curve in Fig. 1 and investment in auxiliary apparatus per transformer installation. Then

$$C_1 = W_1 f C + 8760 W_2 C_4 + C_5 \qquad (3)$$

In deriving the value of f for equation 3 in the case of automatic network systems where circuits may be taken out of service at periodical intervals, the actual load curves for the transformer should, of course, for accuracy be considered instead of the load curve of the whole system. This also applies to all the calculations that involve loss and voltage drop in the secondary mains. However, in cases where the system load factor is high, the practice of taking circuits out of service during light load periods has very little effect on the total losses, since the decrease in core loss is offset to a great extent by the increase in copper loss due to longer distances of feed. In such cases it is permissible to use the duration factor of the system load.

Since the number of transformers per 100 ft. of secondary circuit is represented by the expression $\frac{D}{I_T}$, we have for that portion of the yearly transformer cost per 100 ft. of secondary circuit which varies with the transformer spacing, the expression $\frac{C_1 D}{I_T}$.

In the case of the yearly cost of secondary copper, the portion of the cost that affects the economics is that portion which varies with the size of copper. For overhead systems this can be derived approximately from the cost per pound of copper delivered to the job. The remainder of the cost of overhead lines, including poles, hardware and insulators, is very nearly independent of the size of copper and therefore does not enter into the problem of economics. For underground systems a graph such as that given in the first of this series of articles, which appeared in ELECTRICAL WORLD, issue of March 10, page 501, should be used, only the slope of the straight line being taken and the fixed cost, represented by the intersection with the vertical axis, being excluded from consideration.

Let C_2 equal annual fixed charges on investment in secondary copper in dollars per year per 1,000 circ.mils

per 100 ft. of single conductor, exclusive of installation costs and including only that portion of the cost that is directly proportional to the size of conductor. Let n equal the number of current-carrying conductors in the secondary mains and n_1 equal the total number of conductors in the secondary mains including the neutral (neutral being the same size as the other conductors); then we have from equation 2 the total variable portion of the yearly cost of secondary mains (including losses) per 100 ft. of system equal to

$$\frac{0.183\, nfC\, I_T^2}{1{,}000a} + C_2 n_1 a \qquad \textit{(Formula a)}$$

where a is the conductor cross-section in thousands of circ.mils. The first term of this expression represents the annual cost of losses, and the second term represents the annual fixed charges on investment. Differentiating this formula with respect to a and equating to zero, we have

$$a = 0.01352\, I_T \sqrt{\frac{nfC}{n_1 C_2}} \qquad (4)$$

This expression gives the economical size of copper in terms of load current at the transformer, number of conductors, cost of copper loss, fixed charges on investment and duration factor.

Inserting this value of a in the above expression for total variable annual costs of secondary mains per 100 ft. of circuit (formula a), we have

$$0.02704\, I_T \sqrt{nn_1 fCC_2}$$

The variable portion of the total annual cost of the whole system of 100 ft. of secondary circuit is then

$$0.02704\, I_T \sqrt{nn_1 fCC_2} + \frac{C_1 D}{I_T}$$

the last term being the variable portion of the annual transformer costs. Differentiating this expression with respect to I_T and equating to zero, we have

$$I_T = \frac{6.08\sqrt{C_1 D}}{(nn_1 fCC_2)^{1/4}} \qquad (5)$$

Equations 4 and 5 give the economical size of copper and economical load at the transformer in terms of load density and the various other factors that enter into the problem. These equations are expressions for the complete economics of copper size and transformer spacing, where these quantities can be considered independent of voltage drop or current-carrying capacity of copper. Although equation 5 does not directly express the average size of transformer that should be used in practice, the latter can be easily determined from the load current I_T by applying whatever factor of safety it is desired to use in the loading of transformers. This is a matter of judgment, depending upon the amount of supervision that can be maintained over the transformer loading. In general, it may be said, however, that for good economics the transformers should be loaded to safety limits.

In any given set of calculations equations 4 and 5 should be used first. After numerical values are obtained by means of them the results should then be tested to determine whether the allowable voltage drop or current-carrying capacity would be exceeded by the use of the values thus obtained. Voltage drop can be determined by the use of equation 1. The matter of current-carrying capacity is of course a question of comparing the size of copper obtained from equation 4 with one-half of the value of current I_T obtained from equation 5.

Allowable voltage drop is primarily a matter of quality of service and must be determined by judgment based on operation experience. The direct result of poor voltage is the ill will of the customer but not always a physically decreased energy consumption. Attempts have been made to evaluate mathematically the loss in revenue due to decreased energy consumption caused physically by low voltage at the customer's service. However, the fallacy of such procedure is easily seen, since in the long run a certain percentage of customers will manage somehow to obtain the amount of light or power they require. If their lighting is poor due to low voltage and their complaints to the power company are ignored, they will use bulbs of lower voltage rating or higher wattage, thus bringing their power consumption equal to or above what it would be if the voltage were normal. Furthermore, in systems having primary feeder regulators of sufficient range the average service voltage can be held normal, regardless of the drop in secondary mains. In such cases the voltage drop in secondary copper can have little or no direct effect on power consumption.

The above is not intended to convey the impression

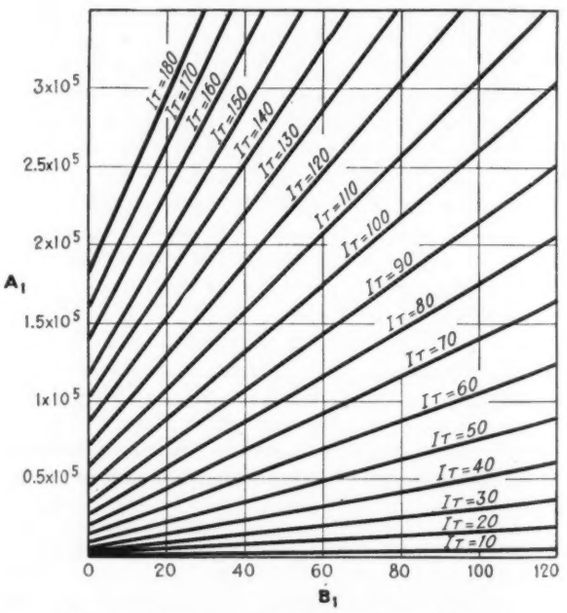


Fig. 2—Economical load at transformer (Equation 9)

that power consumption is entirely independent of the voltage regulation, but merely that there is no direct mathematical relation between the two. It is quite a common occurrence in the reconstruction of old distribution systems to have the improvement in voltage regulation bring about a noticeable increase in power consumption. However, there is usually no convenient means of determining how much of the increase is the direct result of the voltage improvement and how much is due to the increased use of energy in appliances, etc., by some of the customers resulting from the improved quality of service. At any rate there is usually little to be lost and much to be gained by providing service of high quality, and, as previously stated, the exact degree of this quality must be determined by judgment based upon experience.

In systems having no voltage regulators the entire voltage drop between station bus and customer's service must be taken into consideration in determining the allowable voltage drop in secondary mains. However, in systems equipped with feeder regulators the voltage at services nearest to the transformers can be maintained at values slightly above normal, allowing that at services

farthest from transformers to fall slightly below normal. The maximum variation from normal voltage is then only approximately one-half the maximum voltage drop in the secondary mains. This is based on the assumption that the voltage drop in primary laterals is small enough to be neglected, which is quite often the case, as mentioned in the discussion of the primary system. Thus in many systems equipped with regulators a maximum secondary voltage drop of 4 per cent is probably a reasonable allowance, giving a variation from normal at the customer's service of approximately 2 per cent.

By normal voltage is here meant an average voltage slightly higher than the rated voltage of the lamps, since an allowance must be made for voltage drop in the customer's wiring.

If the allowable voltage drop would be exceeded by the use of values obtained from equations 4 and 5, then a new set of calculations must be made considering voltage drop as the limiting factor. An equation for this condition is obtained by inserting the value of a from equation 1, or

$$a = \frac{0.274\, I_T^2}{DV} \qquad (6)$$

in formula a and adding the expression for yearly transformer costs. This gives a total variable annual system cost of

$$\frac{0.183\, DVnfC}{1{,}000 \times 0.274} + \frac{0.274\, C_2 n_1 I_T^2}{DV} + \frac{C_1 D}{I_T}$$

Differentiating and equating to zero, we get

$$I_T = 1.221 \sqrt[3]{\frac{C_1 V D^2}{C_2 n_1}} \qquad (7)$$

If current-carrying capacity is the limiting factor, then the value of a in terms of its current-carrying capacity must be inserted in formula a. For overhead conductors the current-carrying capacity is very nearly proportional to the three-fourths power of cross-sectional area (see any good table of carrying capacities of copper wire), whereas for underground conductors this relation is roughly according to the square root of the cross-sectional area instead of the three-fourths power. (See paper by Donald M. Simons, *Journal A. I. E. E.*, May, 1923.) The occurrence in underground systems of a straight line feed is unusual; therefore it can be assumed that equations for straight line feeds are applicable mainly to overhead systems.

Let b equal the size in 1,000 circ.mil required to carry 100 amp. Then

$$a = \frac{I_T^{1/2} b}{1170} \qquad (8)$$

Inserting this value in formula a and adding the expression for transformer cost, we have a total variable annual system cost of

$$\frac{0.214\, nfC}{b} I_T^{1/2} + \frac{C_2 n_1 b}{1170} I_T^{1/2} + \frac{C_1 D}{I_T}$$

and repeating the process of differentiating, we get an equation of the form

$$A_1 = I_T^{1/2} + B_1 I_T^{1/2} \qquad (9)$$

where

$$A_1 = \frac{878\, C_1 D}{C_2 n_1 b} \qquad (10)$$

and

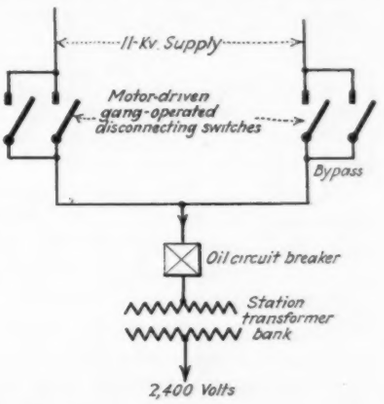
$$B_1 = \frac{125.2\, nfC}{C_2 n_1 b^2} \qquad (11)$$

Equation 9 gives the economical load at the transformer in terms of the various factors that enter into the problem. It has a somewhat complex analytical solution. Therefore, to facilitate its use, the values involved have been plotted as shown in Fig. 2. From this figure the required value of I_T can be found by locating the point the co-ordinates of which are the numerical values of A_1 and B_1, then interpolating between the values of I_T represented by the straight lines of the figure.

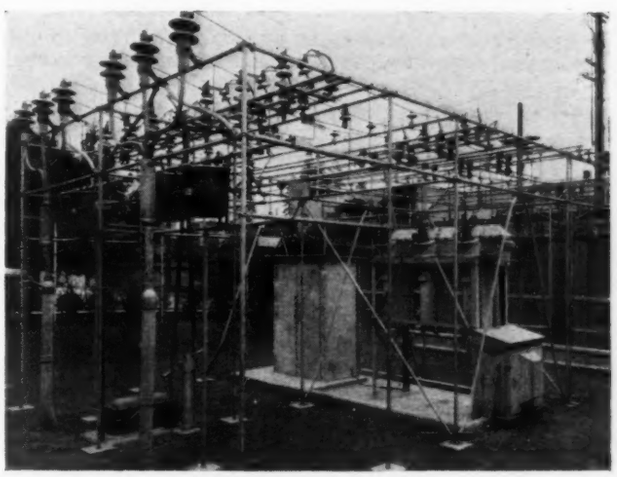
Line-Transfer Scheme Uses Only One Circuit Breaker

By E. F. Pearson
Electrical Engineer Northwestern Electric Company, Portland, Ore.

AUTOMATIC selective transfer equipment is employed by the Northwestern Electric Company in substations to permit using a single 11-kv. breaker for handling two incoming supply lines to each station. Through the elimination of one heavy-duty breaker an over-all saving of approximately $3,000 per station is effected. Motor-driven air-break disconnecting switches automatically transfer a selected 11-kv. line to the circuit breaker. Connections are shown in the diagram.



A single oil-circuit-breaker is used in this line-transfer arrangement. The disconnecting switches are motor operated



In case of trouble on the line from which the station is operating, the sequence of operation is as follows: Relays open the oil circuit breaker, which breaks the load in case the station is not already dead. The motor-driven, gang-operated, interlocked air-break switches then transfer the oil breaker to the other line and the breaker closes and picks up the load. The complete switching operation takes place in five seconds. In case the second line is also in trouble the station will not be transferred, but will take service from the first line to be restored to normal.

The station may be transferred from one line to the other, if desired, without dropping the load by the manually operated by-pass disconnecting switches. In addition to the automatic transfer equipment the oil breaker is also controlled through a periodic-reclosing relay operating on station overload. In case of extreme overload the breaker will open and close twice, at predetermined intervals, and lock out if the trouble still exists after the last reclosure.

All motors and relays are operated with 120 and 240 volts alternating current, while release coils and circuit-breaker trip coils operate at twelve volts direct current.

To date, the first station equipped with this apparatus has transferred circuits three times during emergencies. A check on customers' equipment subsequent to the outages showed that a number of motor-driven ice machines of the meat-market type remained on the line after the transfer was made. This indicates that, in general, ice machines will resume service if the outage is five seconds or less.

Indirect Costs on Transmission Projects

By M. J. Idail
Electrical Engineer for F. R. Weller, Consulting Engineer, Washington, D. C.

CAREFUL cost records kept during the past five years on four large transmission projects show a good uniformity in the relation that the total indirect (or overhead) cost bears to the total cost. The projects studied covered widely different conditions, were for different clients, were handled with different types of construction organization and included tower lines, pole lines and large and small substations. The total cost of the largest project was $3,400,000, the smallest $500,000. Progress rates of the various jobs were such that the average rate of expenditure of money ranged from $170,000 per month to $50,000 per month.

INDIRECT COSTS INVOLVED IN TRANSMISSION-LINE AND SUBSTATION CONSTRUCTION IN TERMS OF PER CENT OF DIRECT COST*

	Per Cent
Injuries and damages (compensation and liability insurance)	1.0
Other insurance (not including car or truck insurance)	0.25
Preliminary engineering investigation	0.25
Home office engineering and superintendence (studies, designs, supervision of construction; costs of engineering, purchasing, general accounting and treasury and legal departments)	3.75
Field engineering and superintendence (construction superintendent; general foremen; field engineering other than surveys)	2.50
Field office and storeroom (bookkeeping and cost keeping; disbursements; material receipt and issuance; field purchases of material)	2.00
Engineering fee and contractor's profit (including fees for home office purchasing, general accounting, treasury, etc., departments)	12.50
Interest during construction	4.50
	26.75

* 26.75 per cent of direct cost is equivalent to 21.4 per cent of total cost

The accompanying table represents the average experience on the projects above outlined and is adjusted for differences in accounting practice. It goes without saying that differences in conditions and accounting practices may cause the reported indirect costs on other projects to be appreciably greater or less than those here given.

In preparing estimates of cost there is a tendency to fail to evaluate justly certain items which are on the border line between direct and indirect costs, to regard such costs as being cared for in the indirect cost allowance, and then to fail to make the indirect allowance sufficiently large. In actual cost keeping, many such items are easily evaluated and are charged to direct cost accounts, and to this extent the actual costs of the direct accounts exceed the estimated allowances. Examples of such items are depreciation on cars, trucks, camp equipment, office equipment, etc.; losses sustained by reason of camp not being self-supporting; local attorneys' fees and title abstract work in connection with easements on land. Field office drafting should be a direct charge against the land account. Truck and car operation, expense accounts of survey party chiefs, subforemen, the chief locating engineer, right-of-way men, etc., are direct rather than indirect costs.

Employees Average 225 Lamps in Pittsburgh Campaign

A SIX WEEKS lamp sales campaign, undertaken in an effort to fill the empty light sockets throughout the territory of the Duquesne Light Company, was recently completed with sales averaging 225 lamps per salesman. A total of 116,739 lamps was disposed of by the 520 employees who took an active part in this work.

A preliminary estimate, according to George E. Whitwell, general sales manager of the company, indicated that 10 per cent of the residential lighting sockets were empty, and while this was not an exceptional condition the employee sales plan was adopted in an effort to remedy the situation because it was felt that the buying of lamps had not been made easy enough and because housewives had not been sold the idea of keeping a reserve supply of lamps on hand.

The work of the employees was stimulated by commissions on sales and the offering of additional cash prizes for those showing the best results. Sales promotional literature was furnished in connection with campaign circulars giving full information regarding the activities. Special order forms were prepared and furnished the solicitors showing various sizes of lamps and prices and employees were kept informed of progress by notations in the general sales manager's weekly bulletins and special bulletins were issued from time to time giving all details and status of the campaign.

Lamps were delivered by the company when desired by the patrons and charges were included on monthly bills for electric service. The special handy carton of assorted lamps was offered at a price of $2.47, containing two 100-watt, three 60-watt, two 40-watt and two 25-watt lamps. Although this was not the only way lamps could be purchased during the campaign, 3,383 of these special cartons were distributed. During this sale 15,683 100-watt lamps were distributed and 40 per cent of all lamps disposed of were of sizes 60-watt or larger.

Every effort was made, according to Mr. Whitwell, to assist competitive lamp dealers in increasing their lamp sales. They were kept informed of all activities in order that they might also "cash in" on the campaign. A series of advertisements was run in the newspapers, suggestions with reference to lamp buying were carried on customers' monthly bills and windows in various stores were suitably decorated. Local dealers were informed in advance of the dates on which these advertisements would appear and were also furnished with copies of reprints in advance in order that they might secure every possible help during the campaign.

Profit vs. Volume in Pricing

Losses in business so general there must be a fundamental cause. Profit an obligation to progress. No justification for a company to operate without a profit if it fills a need

By W. L. CHURCHILL
New York

FORTY per cent of all manufacturers are reporting deficits in their income tax returns on the average year after year; 70 per cent earns less than $5,000 net profit per year; only three firms out of five earn any profits whatever and only three out of ten earn more than $5,000 per year. The average net income of our entire manufacturing group is approximately $2,500,000,000 per year, or a little more than $20 per capita for our entire population. This is less than the amount that is being added to the investment in manufacturing enterprises year after year if the latest reports on this item from the Census Bureau are indicative of current trends. Manufacturing as an economic group does not earn enough to take care of its own expansion requirements created by our increasing population and increasing demand for manufactured products.

How accurately these figures reflect the conditions of the manufacturers engaged in the production of electrical equipment and goods would be difficult to determine. Assuming, however, that as a group it may rate well above the average of all of our manufacturing industries, it is quite obvious that profits are not commensurate with the service that is being rendered. Despite the outstanding and recognized success of prominent electrical manufacturing firms, the number of firms which are not regularly and consistently making a fair return to their stockholders and owners is altogether too large for the industry to assume any complacency over its own position in the structure of American industry generally.

A total productive capacity greatly in excess of the absorbing capacity of the market is pointed out by Mr. Churchill in this article as the basis of two companion evils: First, increased selling cost for selling effort is being expended to dispose of 100 per cent of the industry's capacity; second, price reductions are made in anticipation of a volume sale that is impossible of attainment. The net result is abnormal selling costs, subnormal selling prices and subnormal profits.

LOSSES CONTINUALLY SHIFT ABOUT

This is not a picture of a period of unusual depression. It is a picture that indicates just what occurred in 1927 and that prevailed during the prosperous year of 1926. Neither are the losses confined to small and irresponsible manufacturing firms. Deficits are reported by some of our largest and most prominent industrial enterprises that in times past have been very successful and profitable under the same management. Were it not for the fact that the losses shift about from industry to industry and firm to firm within industries, we would have a larger list of failures and receiverships than we now have.

A condition that is so general and that is not confined continuously to any product, group or class must have a fundamental cause or causes whose discovery will indicate the remedy or remedies. There is no justification for manufacturing enterprises, producing articles or products of service to society, operating without a profit. Quite the reverse is the case. Profit is an obligation, not merely to stockholders and owners but to progress. The manufacturing firm that makes no profit cannot out of its own resources conduct research, experimental and development work for improvement of its product or of its methods of production, or extend its markets. Being unable to do these things, it is unable to reduce costs or give greater values per dollar of sale, and as we cannot stand still, but must go either forward or backward, the firm that makes no profit sooner or later becomes a burden upon the community.

The opposite of this picture is that of a firm making not merely a profit but substantial profits. It is such firms that are responsible for developments and improvements in products that tend continually to lower their costs or give us greater values in the price of their products. It is the prosperous and profitable firms that improve, enlarge and add to their buildings, thus making business good for manufacturers of building materials and for the dealers, contractors, engineers, etc. It is the profitable firm that invests in new equipment, machinery and devices, that in turn employ designers and producers, all tending to increase our general business and progress. Even the cash dividends paid to stockholders become a means of stimulating all forms of business and professional services, improving our standards of living and our cultural levels.

When we recognize that to obtain products or services from worthy producers at prices that give them no profit we automatically restrict our own opportunities for business, then we will be just as insistent upon our suppliers obtaining a profit from our transactions as today we are eager to prevent it. When automobile manufacturers buy their steel at prices that mean a loss to the producers

they automatically destroy a market for automobiles. This, in turn, correspondingly reduces the market for a large variety of electrical devices and equipment. This same reasoning can be followed through to suppliers of wire and other component materials, to the smelters and the mines. It takes but little imagination to see the beneficent effect upon all business derived from profits.

A few manufacturers are far-seeing enough to insist upon doing business only with suppliers who are to profit from the transaction. Others, although not taking quite so unusual a position, try to impress upon the people with whom they deal the importance of the transactions being fair to all parties; not for sentimental reasons but for purely selfish reasons. A large purchaser of public utility equipment has been known to criticise the manufacturers because the latter did not charge enough for their products. His reasoning was to the effect that the prices are so low that there are no profits with which to develop and improve the goods, so that they cost more than they would if liberal profits had been earned in the past and the product is not as advanced as it should be.

Manufacturers of electrical products have made tremendous progress in the short period during which the electrical industry as an industry has been in existence. In the earlier years it was fairly easy to obtain capital from other sources with which to start and develop electrical enterprises. It is getting to be more and more necessary that the industry find its own capital for its further development and progress from within its own sources. It must earn this capital in the form of profits or its progress will be seriously restricted. Electrical manufacturers are already making a beginning in the study of causes and the search for the remedy for existing conditions that are generally admitted to be unsatisfactory from the standpoint of profit as well as from the comparatively slow extension of markets.

Inadequate Average Prices Chief Cause

The principal cause for both of these major conditions, low average of profits and slow development of additional markets, is that the average prices received by manufacturers of electrical (and other) products are inadequate to cover the costs of production and distribution and provide a surplus with which to pay stockholders cash dividends; to improve products so as to enlarge their demand, at the same time reducing their cost, and to enable lower prices still further to widen their demand. Simply stated, electrical manufacturers do not get enough for their goods. They do not get enough for their goods because they do not price them properly. They fail to realize that there are economic laws that must be observed in the pricing and merchandising of their products to insure their operating upon a continuously profitable basis and fulfilling their obligation to society as well as to the stockholders and owners.

As it will be impossible to deal with more than one of the several governing fundamental economic factors in this short article, I simply will touch upon one of the most important of these factors, that of the production volume upon which all costs and profits must be based for the establishment of sound selling prices for manufactured products. Most pricing of manufactured goods is done with the primary object of getting volume business. Electrical manufacturers, like all other manufacturers of established industries, have a total productive capacity greatly in excess of the absorbing capacity of the market for their products. This develops two companion evils. First, it increases selling costs, as selling effort is being expended to sell 100 per cent of the industry's capacity; second, it effects price reductions in anticipation of a volume sale that is impossible of attainment. The net result is that we have abnormal selling costs, subnormal selling prices and subnormal profits.

Costs and Profits Based on Actual Production

To illustrate this feature, the case of the flour industry will be cited. The flour industry is chosen because of the simple nature of its product and the fact that government statistics are available in relation to proportion of production to capacity. For the year ended June 30, 1927, the flour mills of the United States (nearly 800) produced 55 per cent of their rated capacity, included in this being a considerable export production. An investigation discloses that efforts to sell 100 per cent capacity were adding to normal selling costs approximately 40 cents per barrel over and above that needed to dispose of what was produced. This investigation was necessarily limited, but if indicative of the industry as a whole would represent a needless expenditure of $50,000,000 a year that must be saddled onto the cost of the flour that is purchased and consumed. The profits of flour mills are approximately in line with those of general industry; the mills that succeed in obtaining a volume in excess of the average make some money, but the industry as a whole is no better than the average of all of our American industries. Our per capita consumption of flour is about one barrel per year. No amount of sales effort, advertising campaigns or other marketing activities can appreciably increase the consumption of flour in the United States; it is limited by the size of the great American stomach and can be increased only by displacing other products. What is true of flour is true of electrical products, except that the limitations of the American market are restricted to the size of the American dollar.

The electrical manufacturing industries, or different subdivisions thereof, may be disposing of 60, up to, in some cases, 75 per cent of their aggregate capacity, but you may rest assured they are not disposing of 100 per cent or anywhere near that on the average the year round. Figures recently compiled of representative groups of manufacturers, even in the busy period of 1927, range all the way from 40 per cent to 84 per cent. The automobile industry in 1927 operated at about 62 per cent capacity and it is increasing its capacity. A recent statement from the United States Steel Corporation was to the effect that over a period of six years it had operated at 66.6 per cent of capacity. These figures are merely cited to show that manufacturing firms which find that they have considerable idle or semi-idle capacity should first determine the relationship of their production to that of the average of the industry before spending excessive amounts merely to switch trade from some other producers to their plants. They must know upon what proportion of capacity they must build their costs and determine their profits for the purpose of establishing the selling prices before their cost systems can be used as the basis for guiding them to continuously assured profits and the perpetuation of their businesses.

Electrical manufacturers are catering to an expanding business, but productive capacity expands at an equal or greater rate, so that in effect the industry as a whole is selling to a saturated market. The limitations of this market are the limitations of the money available to invest in electrical devices, objects and equipment. Increase the dollars available for expenditure by the American public for its luxuries, conveniences and necessities and

the electrical industry will get a major portion of this increase, as most of the things that we desire today either are directly connected with electrical manufacture or are produced with the use of electrical equipment. The logical means for increasing the money available to the American public is to increase the profits to the large body of American stockholders and owners. To accomplish this it is necessary that all transactions of manufacturing enterprises be conducted with the primary object of profit. When products are priced so low that it is necessary to sell an abnormal volume to insure normal profits these can be secured only by reducing profits and even creating losses for competitors whose trade is diverted away from them. This brings about retaliations; prices are met and still further reduced and normal profits cannot be sustained.

Principle of Pricing an Individual Problem

Fortunately it is not necessary for an individual firm to wait for its competitors to accept and apply the principle of pricing its products upon a basis that will earn it a normal profit when it produces its normal quota of the offering business in order that the adoption of this principle may enable it to operate profitably. Intelligent merchandising will enable proper prices to be obtained and a sufficient quantity of goods to be sold to insure profits. If the merchandising is especially well conducted more than the normal quota of sales will be secured, but at prices that will insure greater than normal profits. On the other hand, sales may fall substantially below the normal quota of business before profits will drop to present average levels if they are subnormal.

It is useless for us to quarrel with the fact that surplus capacity exists. It does exist and in all lines. As fast as we develop business fully to absorb our operating capacity we immediately increase that capacity. Most industries find that at times they are required to utilize all of their capacity, even though it may be but for short periods. Other manufacturers are constantly seeking additional lines, often going entirely outside of their established fields to find articles to produce that will take up the slack of their idle equipment and more fully utilize their organizations. This, in turn, increases the productive capacities of the lines adopted, so that there is a tendency toward the equalization of the utilized capacities of all of our industries. There is a continual effort of adjustment of supply to demand. Our capacity to supply is greatly in excess of demand at present. It is not, however, in excess of the needs and desires of the buying public, but merely in excess of their ability to satisfy them. When manufacturing enterprises earn the profits that they should there will be a large addition to the funds now available to increase the demand.

We have seen the effect of increased wages upon business. Similar effects will follow the elevation of profits to their proper levels. There is nothing reprehensible about profits in themselves. Profits must be earned if we are to continue to progress. They are as well an obligation to stockholders and owners. This thought has been aptly expressed by the Illinois Manufacturers' Cost Association in its report on "Financial Burden in Cost." The concluding paragraph of this report states:

> From a moral, financial and sound business standpoint stockholders are just as much entitled to reasonable returns in the shape of dividends as bondholders are entitled to their returns in the shape of interest. The management of every business and industrial organization assumes a serious responsibility when it accepts stockholders' money. It should expect to meet this responsibility at all times.

To insure this result, manufacturers must adjust their prices so that these profits will be secured when they sell their quota of the offering business. There is no choice in this matter if the primary object is consistent and regular profits that will put manufacturing upon a basis that will make it a sound investment instead of a precarious speculation.

Pricing for profit instead of pricing for volume does not necessarily imply a loss of business. Intelligent merchandising will overcome the tendency in this direction and secure the profits through which cost reductions may be effected and prices lowered to the further benefit of all business. It has been estimated that American manufacturers ought to be earning at least $5,000,000,000 more profits per year than they now obtain. The electrical industry can assist manufacturers generally toward this goal by pricing for profit instead of pricing for volume.

Invites Motorists to Plants and Emphasizes Power Resources

MAINE'S MILLION DOLLAR
Lewiston-Auburn
The INDUSTRIAL CENTRE OF
NORTHERN NEW ENGLAND
Visit Gulf Island Dam - Androscoggin Valley Hydro-Electric Power

TOURISTS in the Androscoggin Valley of Maine are invited to visit the new Gulf Island hydroelectric plant of the Central Maine Power Company through the co-operation of the Lewiston-Auburn Chamber of Commerce and the utility, as indicated by the above billboard, which occupies a prominent place beside a new motor highway traversing this district. The attraction of industries by cheap power is effectively featured by this business organization.

Latest Data on Farm Electrification

A VALUABLE contribution to the available information on farm electrification has just been published by the Committee on the Relation of Electricity to Agriculture in a 136-page booklet, "Electricity on the Farm and in Rural Communities." The booklet, which is issued as C.R.E.A. Bulletin, Vol. 4, No. 1, sets forth material which represents a summary of the best information at the command of the committee regarding rural uses for electricity.

In addition, it contains a review of the organization and activities of the various state and national associatons, agricultural colleges, experimental stations and the power companies working through the Committee on the Relation of Electricity to Agriculture to solve the problem of getting electric light and power service to the farms of the United States.

Among the data presented is an estimate of the number of farms in the country having electric service based on the results of a survey conducted by the rural electric service committee of the National Electric Light Asso-

ciation showing that 227,442 farms in 27 states had service from high lines on Jan. 1, 1927. This was an increase of 86 per cent for the same 27 states over Jan. 1, 1924. On this basis it is estimated that between 300,000 and 350,000 farms in the United States were receiving electric servce from distribution lines on Jan. 1, 1927.

It is significant with reference to the future development of rural electric service that 100 electric light and power companies report one or more men giving especial attention to this subject. Of this number 53 companies report the organization of rural electric service departments or divisions.

Other information set forth in the bulletin discusses different phases of the rural service problem, and the major portion is devoted to specific data on energy consumption of domestic and power applications of electricity on the farm. This information is given in an extensive description of the various applications and supplemented with some 80 tables and 208 illustrations.

Uses 30-Amp., Single-Pole Blocking Switches

By C. E. Schnell
Electrical Designing Engineer San Joaquin Light & Power Corporation, Fresno, Calif.

EVEN with increasing efforts directed toward better and more positive relay protection and with constant refinements in oil circuit breaker design and application to give greater continuity of service, still there are many things which enter into the complete scheme of operation of equipment which may defeat the purpose, such, for instance, as the blocking switch ordinarily inserted in the oil switch trip circuit to render the breaker non-automatic or when it is desired to inspect or work on relays.

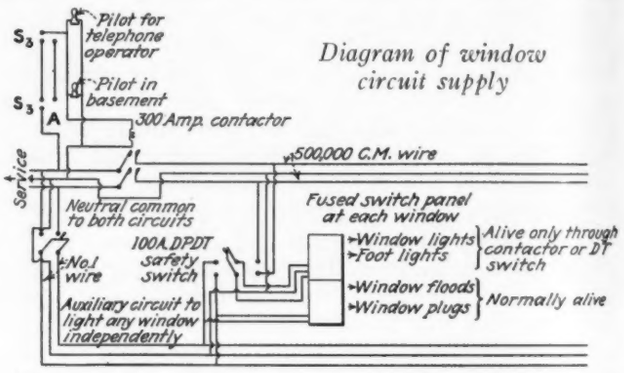
Experience of the San Joaquin Light & Power Corporation has been with the use of a somewhat varied line of switches for this service. The single-pole indicating snap switch, the single-pole tumbler switch with indicating handle and the single-pole knife switch all have been used. The two first mentioned have caused trouble due to incomplete and uncertain contact as well as flimsy construction, and while the tumbler switch gives the better appearance it has been the worst offender in this regard. While perhaps not so pleasing in appearance on the face of a switchboard, but because of more rugged construction, it has been decided to use for this service 30-amp., 125-volt, single-pole, single-throw knife switches mounted on the front of the board, but with studs for rear of the board connection. These are located near the relays whose tripping circuit they control and not only make a positive contact when closed but give a very desirable visual indication of their position at all times.

Blocking switches are operated only on direct instructions from the system load dispatcher, and it is the operator's duty carefully to check his board for proper position of these switches. During system disturbances, when an important line may be out of service, it is possible by opening the blocking switches on other lines to load them in excess of their normal relay settings until the period of such emergency operation is over. This does not disturb the relay setting and the blocking switch is closed on return to normal conditions, thus again making the automatic protective features effective.

Refractor-Plate Lighting Gives Even Window Illumination

THE department store of the C. T. Sherer Company, Worcester, Mass., is reported to be the first in the country to be equipped with prismatic refractor-plate window lighting. The installation is wired and equipped for a total capacity of 500 watts per foot overhead, the use of 150 watts per foot for the foot lighting, and numerous other outlets for floods, displays, etc. The present load of the windows is 350 watts per foot, including foot lighting. Seventy-eight plates and reflectors are used in three front windows; 88 circuits are provided for these, with 50 additional circuits for five side windows. Of the former, about 60 are used for overhead and foot lighting.

The illumination equipment consists of a row of light-directing Holophane plates, each about 1 ft. square and mounted separately or in groups in walnut frames. Each frame is fitted with hinges and latches to permit easy maintenance, lamp renewals and the insertion of color equipment. Plates and reflectors for this installation are mounted at an angle, the inner edge of the plates being at the ceiling line with the edge nearest the glass



These windows are wired for two-point remote control at switches S_3, or control by clock or other switch at *A*. An auxiliary supply circuit independent of the contactor control is provided with a double-throw safety switch, enabling the major window displays to be lighted by either of the branch circuits shown.

dropped 15 deg. below the horizontal. In addition, the light distribution is controlled by the filament distance from the plate surface and by the offset position of the reflector to the axis of the plate. Reflectors are mounted on Curtisstrip. In this type of construction the wireway rests on blocks cut at the desired angle. The reflectors can be moved either horizontally or vertically to obtain the desired lamp position.

An important feature is the use of spill light. No housing is located over the reflectors, and this light therefore is allowed to illuminate the store ceiling and, still more important, a light-toned transom curtain. Viewed from outside, there is an attractive effect of size and height along the entire store front which would be absent if everything above the window proper were left in blackness.

The foot lighting is unique in the use of 6-in. prismatic plates in place of the ordinary clear or diffusing glass. This results in improved distribution, doing away with the flux in so many other cases thrown into the eyes of passers-by. Lamps are located back of every other plate, or on 12-in. centers. As seen in the corner window, all plates appear to have about the same brightness, though differences can be noted when viewing them from inside or at comparatively wide angles. For the

foot lighting 100-watt lamps are used. The foot lighting approximately doubles the background intensities at the desired heights.

At present the overhead lighting is by 200- and 300-watt lamps installed alternately along the window frontage portion of the ceiling.

For the current supply to the windows a feeder circuit of 500,000 circ.mils is installed, equipped with a remote-operated contactor. Control buttons and pilots

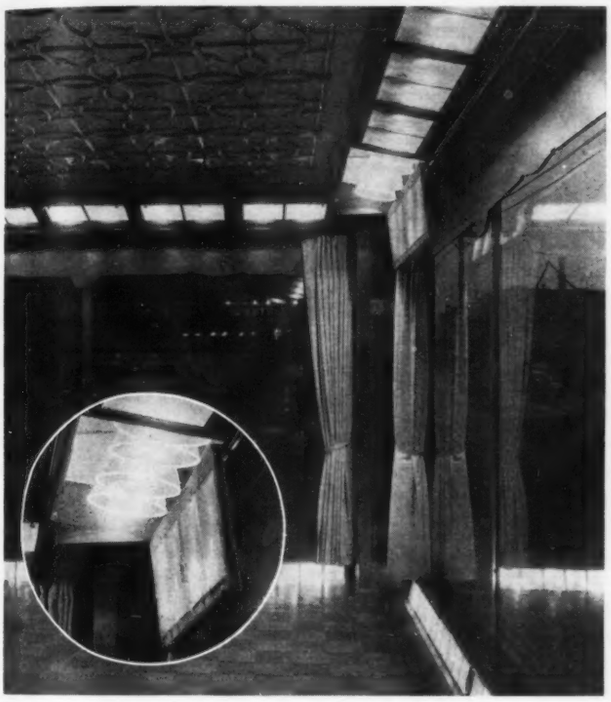


Plate lighting installation of corner window; reflector mounting shown in insert

are provided at two different points for turning all the windows on or off. The contactor method of control allows the use of any auxiliary device, such as a low amperage time clock, if desired. An auxiliary circuit also feeds double-throw switches at the switch cabinet for each window, which enable any window to be lighted independently for special occasions or during decorating and trimming work.

Assets

Our greatest business asset is the good will of the public we serve and it cannot be insured or treasured in a strong box—nothing but satisfactory service will safeguard and maintain it.

CONSUMERS POWER COMPANY
C. W. TIPPY,
Vice-President & General Manager

Letters from Our Readers

Purchasing Agent Not Concerned With Price Cutting

To the Editor of ELECTRICAL WORLD:

Referring to your recent article entitled "Who Pays the Cost of Price Cutting?" I would like to speak a word for the purchasing agent. The old law of supply and demand regulates the price of the commodity, and we are only concerned with getting values proportionate to the money we pay at the time of purchase, predicated on the price of raw material at that time. Price is important with us, but we want the best material we can buy, at the best price the manufacturer can make us, without his losing money, as we know no manufacturer can thrive without making a profit.

Speaking about the methods of buying, all deceit, trickery and pitting of salesmen against one another, as mentioned in your article, should be stopped.

On all large purchases, where bids are asked for, on electrical or any other material, where specifications, blueprints, etc., are furnished, and all bidders are bidding alike, the lowest bidder should be awarded the contract. If it is stated that all bids are to be in at a specified time, then, after all bids are in, no bidder should be allowed or asked to revise his price. This is the only way to get honest competition, as the bidder knows he is getting a square deal and, if his price is the lowest, will be awarded the contract. If the purchasing agent feels that the prices are out of line and too high, all bids should be rejected and new bids asked for.

The purchasing agent is not concerned with price cutting; we want the best price, predicated on the price of raw material, and want value received for the companies we represent.

JOHN R. MCGIVNEY,
New Orleans Public Service, Inc. Purchasing Agent.

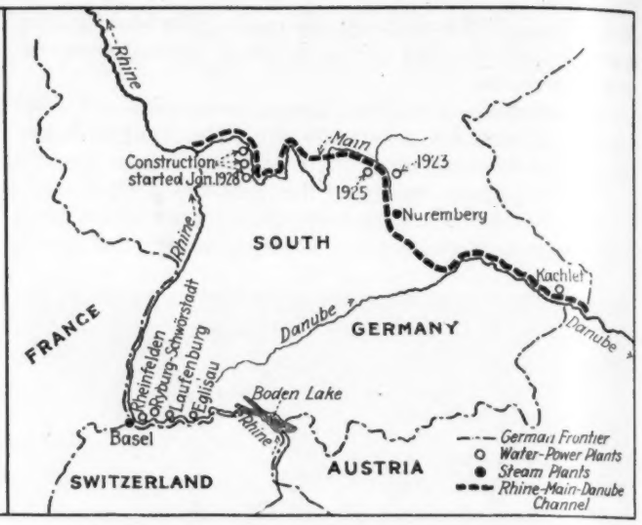
How Electrical Development Is Proceeding in Germany

To the Editor of ELECTRICAL WORLD:

Official statistics published in the last half of 1927 show that at the close of the preceding year there were in Germany 26 generating stations, devoted mainly to the public supply of electric light and power, each of which sold more than 100,000,000 kw.-hr. in 1926. Two of these stations disposed of an output exceeding 1,000,000,000 kw.-hr. The table shows the capacity and the sales of these plants. With these figures as a background, the latest undertakings in Germany in connection with the supply of electricity stand out in their proper significance.

The undertaking of the Rhine-Main-Danube Company, founded in 1922 to build a waterway connecting the River Rhine—rising in the Alps and running through west Germany—with the Danube, which flows through the southern part of Germany before crossing Austria, Hungary and the Balkan countries on its way to the Black Sea, is on its way to successful completion. The project involves a wide channel navigable by boats of 1,500 tons, but its importance from the electrical point of view lies in the water-power sites developed concurrently with the improvement in navigation. These will, when completed, deliver to 35 power stations nearly

Cities in which the largest German light and power companies have headquarters



Rhine-Main-Danube Channel and hydro-electric plants on the upper Rhine

(The numbers refer to the table)

1,500,000,000 kw.-hr. a year, the average aggregate load of the stations being estimated at 250,000 hp.

The waterway is to run from the Rhine to the Main, crossing the Jura Mountains and descending again to the Danube. The power plants are built on sluices supplied from the main canals. The first plant was opened in 1923 with 4,350 hp., the second in 1925 with 4,800 hp. The largest plant yet built, not far from the point where the Danube leaves German territory, was begun in 1922 and went into service in the last months of 1927. It is rated at 75,000 hp. and generates nearly 275,000,000 kw.-hr. annually. Energy from it is distributed by the Betriebsgemeinschaft Kachlet-Franken, which, besides this enterprise, leases at Nuremberg, Bavaria, the 80,000-hp. plant of the Grosskraftwerk Franken.

Construction of the Rhine-Danube waterway has been made possible only by its power-generating features, the income of the power stations being charged with 90 per cent of the cost of the scheme. As utilization of the energy grew slowly in extent, construction of hydro stations was suspended for a few years, but in January last three additional ones were begun under contract with the Bavarian State, and everything now indicates that the project will be carried out in its entirety.

On the upper reaches of the Rhine also construction of a large hydro-electric station, to be known as the Ryburg-Schwörstadt, has recently begun. The Upper Rhine has a fall of 500 ft. between Boden Lake and the town of Basle, 104 miles distant. A channel for large ships is to be built through the rapids. As the Rhine at this point forms the boundary between Germany and Switzerland, these two nations will share in developing the sixteen sites selected. The existing power stations on this part of the Rhine are rated as follows: Kraftübertragungswerke Rheinfelden (German), 48,400 hp.; Laufenburg (Swiss), 69,000 hp.; Eglisau (Swiss), 42,000 hp. The new station, a few miles above Rheinfelden, will have four Kaplan turbines, with a total capacity of between 40,000 hp. and 120,000 hp., according to the flow. A possible development of 500,000 hp. is indicated. The output will average 650,000,000 kw.-hr. a year. Four shareholders have an equal interest in the undertaking—the Swiss government, the German state of Baden, the Kraftübertragungswerke and the Swiss company "Motor-Columbus," which owns the Laufenburg development. The plant will cost 60,000,000 Swiss francs (about $11,500,000), and energy will be generated, it is estimated, at a primary cost of about 0.3 cent a kilowatt-hour.

GERHARD DEHNE.
Berlin, Germany.

Large Central Stations of Germany (1926) with Output and Installed Capacity

	Energy Sold in 1926 (Millions of Kw.-Hr.)	Installed Capacity (Kva.)
1. Elektrowerke A.-G. (Berlin)	1,396.6	475,450
2. Rheinisch-Westfälisches Elektrizitätswerk A.-G. (Essen)	1,218.7	612,000
3. Berliner Städtische Elektrizitätswerke A.-G. (Berlin)	716.8	300,980
4. A.-G. Sächsische Werke (Dresden)	528.8	231,405
5. Bayernwerk A.-G. (Munich) (Walchenseewerk A.-G.)	307.0	122,600
6. Vereinigte Elektrizitätswerke Westfalen G. m. b. H. (Dortmund)	274.6	229,520
7. Märkisches Elektrizitätswerk (Berlin)	266.9	104,355
8. Elektrizitätswerk Sachsen-Anhalt A.-G. (Halle-on-Saale)	245.0	46,400
9. Preussische Elektrizitäts A.-G. (Berlin)	237.0	127,380
10. Hamburgische Elektrizitätswerke A.-G.	231.3	122,310
11. Kraftübertragungswerke Rheinfelden	216.7	29,200
12. Rheinisches Elektrizitätswerk im Braunkohlenrevier A.-G. (Cologne)	212.1	170,700
13. Mittlere Isar A.-G. (Munich)	181.3	92,000
14. Elektrizitätswerk Schlesien A.-G. (Breslau)	164.2	140,120
15. Badenwerk A.-G. (Karlsruhe)	162.3	73,450
16. Schlesische Elektrizitäts und Gas A.-G. (Gleiwitz O. S.)	155.3	81,000
17. Elektrizitätswerke der Stadt Köln	147.4	15,000
18. Kommunales Eletrizitätswerk Mark A.-G. (Hagen, Westphalia)	140.2	122,110
19. Städtische Elektrizitätswerke München	130.8	60,835
20. Grosskraftwerk Mannheim A.-G.	129.7	37,500
21. Braunkohlen und Industrie A.-G. Zukunft (Weisweiler)	120.4	67,500
22. Betriebsgemeinschaft Kachlet-Franken G. m. b. H. (Nuremberg)	116.9	80,500
23. Nordwestdeutsche Kraftwerke A.-G. (Hamburg)	115.7	88,090
24. Grosskraftwerk Franken A.-G. (Nuremberg)	113.7	
25. Uberlandzentrale Pommern A.-G. (Stettin)	107.8	75,994
26. Lech-Elektrizitätswerke A.-G. (Augsburg)	107.1	59,450
Totals	7,744.3	3,565,849

Digest of Electrical Literature

Transmission, Substations and Distribution

Kelvin's Law for High-Voltage Transmission Lines.—R. ROBERTS.—An exposition of the fundamental characteristics of the economic law for electrical power transmission developed many years ago by Lord Kelvin and adapted to the requirements of modern practice, with particular reference to conditions in Australia. It is stated by the author that while the law remains fundamentally correct in principle it is, when applied to modern high-voltage transmission lines, not the simple relationship it was once thought to be. In this discussion the formulas and load charts necessary for the development of the idea and a critical discussion of the values involved are offered. As a result of this investigation it is concluded that it is in general desirable to have synchronous condensers distributed over large transmission systems, but placing the centers of gravity at the loads; induction regulators should be used for particular feeders emanating from generating or substations, and that as there is an economic section of transmission line conductor, it is apparently preferable to use this economic section and to control the line pressure by devices located where necessary, although large copper sections for regulation purposes only are economically unsound.—*Electrical Times (Australia)*, Jan. 27, 1928.

Problems in Connection with Three-Phase Star Loads.—ALEXANDER RUSSELL.—The discrepancy between the value of the power factor of a balanced three-phase load obtained by the two-wattmeter and the three-wattmeter methods is mentioned by the author, as is the deviation in the ratio of the mesh voltage from the star voltage to earth from the theoretical value of the square root of 3. The author investigates the reasons for these variations and with the help of solid geometry develops a pictorial method of considering the problem. It is proved that the square root of 3 is the maximum value of the ratio of the mesh voltage to the potential difference between a terminal and earth. It is also indicated that a star inductive load only has an equivalent mesh load when the time constants of the arms of the star load are all equal.—*Journal of the Institution of Electrical Engineers (England)*, February, 1928.

Units, Measurements and Instruments

Determination of the Moment of Inertia of an Electrical Rotor.—T. F. WALL.—Several methods of measuring the moment of inertia of rotating parts by means of the principle of oscillations are offered by the author and numerical values obtained by these measurements for specific machines are offered and compared. It is stated that the calculation of the moment of inertia of a composite structure like the rotor of an electrical machine is a very laborious process and cannot be expected to give accurate results without a great deal of arithmetical work. The methods considered include: The rotor removed from its bearings and arranged with its shaft supported on horizontal knife edges; the rotor suspended by means of ropes and wires and oscillated under gravity control; the rotor suspended by a single steel wire and allowed to oscillate torsionally about the axis of the shaft; the rotor caused to oscillate in small bearings about its shaft axis. The values obtained by these methods are useful in securing actual quantities for the measurement of the losses of the machine. It is stated that the performance of alternators in parallel is largely dependent on the magnitude of the moment of inertia of the rotating members of the respective machines.—*Engineering (England)*, Feb. 24, 1928.

Extensometer for the Determination of Young's Modulus for Concrete.—V. C. DAVIES.—The author has devised an extensometer particularly adaptable to the measurement of concrete test specimens. In the design particular efforts were made to secure an instrument which might be placed on the specimen while the latter is in position in the testing machine and which would be able to take specimens up to 4½ in. square. Previous experience on delicate extensometers has shown the necessity of securing a device which can be calibrated when fixed in position for test. The method of calibration employed is identical with that used in the well-known Ewing extensometer. The actual measuring device is arranged to measure the relative movement of a hardened steel screw fixed in the bottom frame and the flattened face of a cylindrical rod fixed in the top frame. The end of the calibrated micrometer is made hemispherical and this makes contact with the hardened steel cone fixed in the top frame. A bell-crank lever is pivoted to the framework so that the motion of the hand is magnified through a contact point by about 5 to 1. The end is provided with a jewel end-stone, making contact with the hardened steel point projecting from the frame of a swinging mirror. The movement of the bell crank is resisted by a long light cantilever spring, while contact between the point on the mirror frame and the end of the frame is maintained by means of a hairspring placed on the pivot arbor of the mirror. Both bell-crank lever and mirror frame are carried on cone pivots fitting into conical holes in the ends of small hardened steel screws.—*Engineering (England)*, Feb. 3, 1928.

Heat Applications and Material Handling

Industrial Electric Heating.—The results obtained with specific installations of industrial electric heating in several British manufacturing plants are covered by this article. Operating costs developed as a result of several investigations indicated that the cost of maintaining an electrical industrial heating device was no higher than that for any other apparatus and that the same statements might be applied to operating costs giving in many cases a total cost much lower than that when other forms of heat treatment are used.—*Electrician (England)*, Feb. 3, 1928.

Electrophysics, Electrochemistry and Batteries

Modern Research on the Structures of Metals.—WHEELER P. DAVEY.—Research and development work with X-rays has been the special consideration of the author in this report of the activities of industrial research laboratories. The problems have been divided into several classifications, including, getting the factory out of manufacturing difficulties; development of new products and processes, and search for new scientific principles which may be applied to industry. It is stated that it is in the discovery of new facts or hitherto unknown ones upon which the future factory processes may be developed that the greatest usefulness of X-ray investigations is found. Practically all work of this sort depends upon the measurement of inter-atomic distances. These distances are so small that they cannot be measured directly. By the use of X-rays of known frequency in conjunction with the application of an X-ray defraction apparatus as a micrometer, these extremely small distances may be evaluated. Mention is also made of the method by which study may be undertaken of the mechanisms of melting which serve to correlate the melting point with the total expansion of the metal from absolute zero to the melting point. It is said to have been possible to prepare wire of certain alloys in a state of extreme purity by never permitting the metals to become melted even when making the alloy. Reasons for variations in physical properties are given.—*Journal of the Franklin Institute*, February, 1928.

The Effect of Impurities on the Corrosion of Metals.—COLIN J. SMITHELLS.—The prevention of corrosion is one of the most important problems confronting engineers and metallurgists at the present time and the enormous saving which results from each advance in this direction constitutes an important step in present-day engineering prac-

tice. Among the factors which influence corrosion the composition of the material is one of the most important. In this article the effect of impurities in metals is discussed in relation to the modern electrochemical theory. It is stated that the main factors which determine the influence of impurities on corrosion are electro-potentials of the metal and the impurity, the hydrogen ion concentration, the over-potential value of the impurity and the character of the corrosion product. Specific considerations for the more common metals and for the product formed by their destructive corrosion are offered in connection with the discussion. In conclusion, the author states that while the electrochemical theory leads to an expectation that corrosion resistance will be closely related to the constitution and structure of a material, the examples given indicate that it may also be applied to those small variations in composition which naturally occur in manufacture. Comparatively small changes in composition or the introduction of impurities to the extent of less than one part in ten thousand may materially modify the ability of an alloy to withstand corrosion in service.—*World Power,* February, 1928.

Illumination

Lighting in Industry. — DUGALD C. JACKSON.—The problems involved in industrial lighting have been reduced largely to a research basis in this discussion. The subject is stated to involve three branches of science—physics of light, psychology, and physiology. The research was divided into a study and analysis of the scientific and industrial literature to determine previous accomplishments and a sound basis on which to start on a new investigation; experimental work by psychologists to supply certain information regarding sensitivity, discrimination, acuity, and fatigue that seem to be important in such an investigation; experimental work of a laboratory nature or under controls corresponding to those of a laboratory for the purpose of securing an understanding of the relation of scientific investigation of the conditions under which the conclusions may be applied when they are carried out in industry, and co-ordinated research in the study of factory workers, measurements of factory production, under different conditions of illumination, surveys of eye strain and general fatigue, and the adaptation of conclusions and inferences secured in the other branches ot the investigation to application in the procedure, observation and conclusions of this branch, along with suitable verification of the soundness of the conclusions regarding "workers' efficiency." This discussion, the author of which is chairman of the Committee on the Relation of Quality and Quantity of Illumination to Efficiency in Industry, has resulted in a number of interesting recommendations and determinations. — *Journal of the Franklin Institute,* March, 1928.

Telegraphy, Telephony, Radio and Signals

The Measurement of Acoustic Impendance and the Absorption Coefficient of Porous Materials. — E. C. WENTE and E. H. BEDELL.—Various ways of determining the acoustic impedance and the absorption coefficient of porous materials from measurements on the standing waves in tubes are discussed. In all cases the material under investigation is placed at one end of the tube and the sound is introduced at the other end. Values of the coefficient of absorption of a number of commonly used damping materials as obtained by one of the methods are given. Several types of built-up structures are shown to have a greater absorption coefficient for low frequency sound waves than is conveniently obtainable by a single layer of material.—*Bell System Technical Journal,* January, 1928.

Methods, Formulas and Tables for the Calculation of Antenna Capacity.—FREDERICK W. GROVER.—The calculation of the capacity of an antenna has been developed upon the assumption of a certain charge upon the antenna and from which the resulting potential may be calculated. As the law of the distribution of the charge is not known difficulties are encountered in this method. The assumption has been made that sufficient accuracy is attained if at first a uniform distribution of charge is supposed to exist and the potential calculated at various points of the antenna, the average of these potentials being taken as the final equilibrium potential, but as the discrepancies between the values obtained by this method and the published values for the same antennas by the inductance method differ a factor of uncertainty is involved. The author demonstrates that if appropriate inductance formulas are employed the two methods will agree. Formulas are given for the common types of single and multiple wire antennas in a form convenient for numerical computation, together with tables of constants which will be found useful in such calculations. In addition tables of capacities of both horizontal and vertical single-wire antennas and horizontal two-wire antennas have been included which should render all calculation unnecessary in many important practical cases. —*No. 568 Scientific Papers of the Bureau of Standards.*

The Attenuation of Wireless Waves Over Land.—R. H. BARFIELD.—A description of a series of experiments undertaken to determine the attenuation of wireless waves over land. The intensity of the signals from the London broadcasting station 2 LO was measured along a number of radial lines in seven different directions up to a maximum distance of 100 miles. As a result of these measurements curves were prepared of the over-all attenuation, and derived curves showing only the surface absorption effect were produced. The experimental results were then compared with those obtained in accordance with the theory of Sommerfeld. The results indicate that the effects are not the same in all directions, the difference being quite important and considerably greater than that to be expected from previously determined values of the earth's conductivity. The conclusion of the author was that the greater part of the discrepancy between Sommerfeld's theory and experiment could be ascribed to the effect of trees, and also that the same agency offered a satisfactory explanation of the difference of attenuation observed in different directions—the greatest attenuation corresponding to the most-wooded regions, and vice versa.—*Journal of the Institution of Electrical Engineers (England),* February, 1928.

Miscellaneous

Light Metals and Alloys—Aluminum, Magnesium.—The physical and mechanical properties of aluminum and magnesium and their light alloys and the variation in properties caused by changing the composition of the alloy, by the presence of impurities, by mechanical working, by changes in conditions of manufacturing operations and by heat treatment, are given. The selection of the data available has been made and the data have been checked by representatives of the light-alloy industries in order to present reliable information. Equilibrium diagrams for the important alloy systems are presented, and the metallography, corrosion resistance and methods of protection against corrosion, the theory of heat treatment and the application of the alloys to industry are likewise discussed.—*No. 346, Publications of the Bureau of Standards.*

An Electric Suction Dredge.—An electrically operated suction dredge receiving power on board the vessel at a potential of 11,000 volts has been installed in a government development scheme in New Zealand. Power is taken from an 11,000-volt, three-phase transmission line at such points as may be nearest the section of the river to be dredged. An overhead line is run from there to the river bank and is carried in each direction for 1½ or 2 miles. A cable may also be laid across the river and other lines have been erected for same distance on the opposite side. The tap line is protected on the pole nearest the transmission line by an air-break switch, an oil switch with over-load trips and similar equipment. Air-break switches are erected at intervals on the river bank to enable the dredge engineers to isolate part of the line they are working on without the necessity of going to the extreme end of the tap line to do so. While the dredge is operating on one section the lines erected in a previous section are taken down and re-erected as desired. From the high-potential compartment a three-core cable is taken to a 300-kva., 11,400-volt, oil-cooled transformer and from there to a low potential compartment with distribution to the main pump motor control panel. — *Electrical Review (England),* Feb. 24, 1928.

News of the Industry

Johnson Submits Boulder Dam Report

California Senator Argues that the Bill Is Well Considered and Sound—House Committee Preparing New Measure on Muscle Shoals—Trade Commission Questionnaire

SENATOR JOHNSON of California on March 21 submitted to the Senate the majority report on the Boulder Dam bill. The report covers 31 printed pages. The amendments are discussed and the general project is outlined. Reasons are advanced to show why the project should be financially attractive to the government. Another section attempts to prove that the project has been fully investigated and that the federal government is the proper agency to undertake the development. A chapter is devoted to the Colorado River compact, and arguments are advanced in an effort to show the urgent need for flood control. Still another part of the report deals with the feasibility of the all-American canal and tries to show that there is not sufficient water for all. A chapter is devoted to power and an effort made to demonstrate that the project is financially sound. In conclusion the report says:

The people of the Southwest are not asking of the government this great public improvement as a gift. All they ask is that the government lend its good offices to make this development possible. Established communities and responsible agencies will bind themselves to return to the government all moneys expended. The varied interests concerned with the development make a centralized agency necessary. The government is the logical agency. The beneficiaries assume all the financial obligations. Nor is this quite all. After the development is paid for the government still will retain ownership and control of the dam for such use as the Congress may deem wise and just. It is a great constructive improvement, not experimental, sound financially, well considered, shaped in the public interest, one the consummation of which will be a source alike of national pride and advantage.

Representative Douglas of Arizona has submitted a minority report from the House committee covering 45 printed pages. In it he says that he is opposed to the measure because of its unsound economic nature and not because he represents Arizona. He emphasizes particularly the contention that the project is not one for flood control, irrigation, domestic water or navigation, but does look to the development of the largest power project ever owned and operated by a government.

Another Muscle Shoals Bill

After voting down the Norris Muscle Shoals bill (transmitted from the Senate), the Madden bill and the Morin bill, the House committee on military affairs has plunged into an effort to bring out a bill of its own. This bill is expected to set up a hundred-million-dollar government corporation to operate the property, make fertilizer and sell the surplus power. It is a radical departure from the Senate's plan and is not likely to meet approval there.

The House committee was not satisfied with the Norris bill because of its infringement on the rights of the states in the matter of control of rates and because the members did not regard the plan for fertilizer as a practical one. The Madden bill was even less acceptable. Some members of the committee feel that it is a gesture toward fertilizer production with the real intent of obtaining the power. The fertilizer guarantee was not satisfactory. The fact that the bidder for the property was not willing to turn it back if the fertilizer production should not succeed is cited as evidence strengthening the committee's impression. The refusal of the bidder to increase the offer when it was established that the Cove Creek dam and dam No. 3 would cost more than had been estimated also had influence.

The House committee regarded the Norris bill as a hodgepodge measure, interlocking the responsibilities of two executive departments in an impracticable fashion and complicating rate regulation. There was objection to additional installation on the ground that that depreciation would more than offset the limited use which could be made of the additional equipment. The fact that this machinery would use only secondary power would render it of small value unless the plant were a part of a large system.

Another suggestion which has been put forward is that the President be empowered to lease the plant. Should he fail to receive offers satisfactory to him, he is to be empowered to operate the plant until such time as a satisfactory offer may be forthcoming.

Trade Commission Questionnaire

An eleven-page questionnaire has been sent to all electric and gas public utility companies by the Federal Trade Commission in connection with its inquiry into the conduct of those activities. The principal information requested follows: State of incorporation; date of incorporation; production; purchases and sales; distribution within state; distribution in other states; production within state; production in other states; companies from which purchases were made since Jan. 1, 1927; location and capacity of plant; names of companies with which interconnected; states in which transmission and pipe lines extend; gross earnings for 1927; net earnings from operations; number of shares, par value and book value, common and preferred stocks as of Dec. 31, 1927; amount of bonds and other long-time obligations; surplus; surplus reserves; persons or companies owning 1 per cent or more of voting stocks; ownership of stock in other companies; names of directors and chief officers; names of companies performing management, engineering, financing, construction, purchasing or other services.

A favorable report on the bill authorizing the Federal Power Commission to employ its own personnel has been made to the House by the committee on interstate and foreign commerce.

Senators Find Fresh Fault with Utility Companies

Charges against the public utility industries continue to be made by United States senators. On Wednesday Senator Johnson of California read a photostatic copy of a letter which he said had been broadcast by Milton W. Harrison, president of the National Association of Owners of Railway and Public Securities, to holders of such securities, urging them to unite for protection "against unsound public discussion and unwise legislation" and to contribute $1 apiece to that end. The California Senator declared that if every stenographer, clerk and employee of corporations who had purchased a share of stock in them were to make a contribution, the collection would rival any fund ever collected.

At the same time Senator Walsh of Montana charged that public utility associations were "subsidizing lecturers and professors in colleges to instill in the minds of the youth of the land their peculiar views of public questions." Senator Norris of Nebraska wants a Federal Trade Commission investigation into newspaper purchases said to have been made or to be pending by Ira C. Copley, a former member of the House of Representatives and well-known utility man in the Middle West.

Radio Bill Passes House

The conference report on the bill extending the life of the Federal Radio Commission for another year and embodying the new plan of distributing wave lengths and power was adopted by the House of Representatives on Wednesday, almost without opposition. Indications are said to be that the report will be accepted by the Senate and approved by the President.

Engineering Section, N.E.L.A., Adopts Objectives

At the meeting of the executive committee of the Engineering National Section of the National Electric Light Association held at Louisville this week definite objectives were approved for the engineering committees to work toward. These objectives, as stated by Chairman E. C. Stone, are: More system capacity per dollar of investment, more kilowatt-hours per kilowatt of system capacity, a definite advance planning of system development and co-ordination of adjacent systems, comprehensive research in fundamental engineering problems of the industry co-ordinated through the committees, better conduct and wider distribution of serial reports, study of (and when desirable reports on) national engineering issues affecting the industry, constructive co-operation in the national movement for standardization, and greater engineering service to the industry through closer co-operation with the other national sections of the N.E.L.A. These objectives were approved with enthusiasm by the section members.

The various committees of the section met to discuss current work and to plan future work. The desire to realize more from investment dollars was evident in all the meetings, and much work was discussed or planned to bring about this result. Layouts for power stations, transmission systems, substations and distribution systems were analyzed to ascertain the best way to get acceptable service with a maximum simplicity in layout and a minimum investment. The use of automatic devices to reduce labor charges and improve performance was measured in terms of relative capital and operating costs in power stations. The prime movers committee discussed recent designs in terms of operating performance in an attempt to reach conclusions which would lead to maximum investment efficiency in the generation of energy. The overhead systems committee dealt largely with standards for wires, cables and construction whereby investment savings might be realized and better service rendered. Much was done to co-ordinate test work by utilities on such apparatus as oil breakers, lightning arresters and cables.

Technical discussions on metering, cable research, bin and unit pulverized-fuel systems, system frequency and load control and oil breakers took place in committee, and serial reports were presented and discussed which dealt with important engineering subjects. Accident prevention and inductive co-ordination committee activity was along constructive lines. General discussion showed a consensus of opinion against the proposal to merge the Safety Code and the Electrical Code.

Inspection trips were made to the hydro and steam stations in the vicinity and to Mammoth Cave.

Collapse of St. Francis Dam Unexplained

State, City and County Engineers Have Differing Opinions—Southern California Edison Gains Credit—City's Resumption Plans—Mead Will Head Investigators

ALTHOUGH agreed in discounting any theory that the St. Francis Dam disaster resulted from dynamiting or other sabotage, widely diverging opinions as to what caused the structure in San Francisquito Canyon to collapse and spread death and destruction throughout the Santa Clara River Valley have been expressed by engineers on the ground.

Edward Hyatt, Jr., State Engineer, blames foundation weakness in the abutments of the dam, refusing to express an opinion on whether the collapse was due to engineering mistakes or to causes over which man has no control.

William Mulhollan, chief engineer of the Los Angeles Bureau of Water and Power, under whose supervision the dam was built as a unit of the city's water system, declared his belief that a series of landslides above the dam caused the collapse. Other Water and Power Bureau engineers reported finding evidences of three slides.

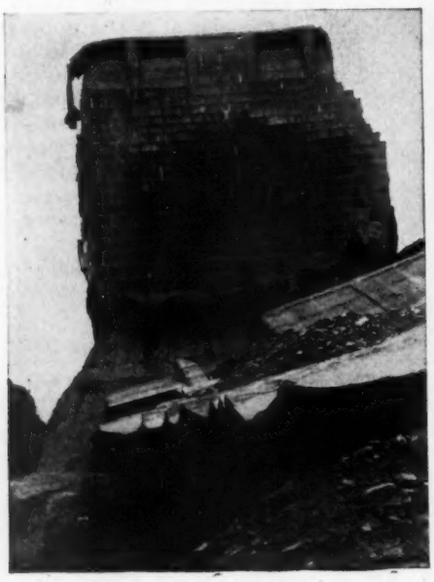
Charles Petit, county engineer of Ventura County, sharply criticised the foundation rock on which the sides of the dam were built. "It is my opinion," Mr. Petit added, "that a dam never should have been constructed at this point. The rock all seems to be largely of the same type."

As the illustrations below show, not only is the center part of the dam still erect but the two generators remain in the canyon firmly resting on their foundations, although the power house itself has been swept completely away.

The outstanding feature of the situation is the remarkable manner in which the Southern California Edison Company came to the rescue and made up the deficiency in the city's supply of energy caused by the cessation of service from the city plants. It is a feather in the cap of the company and a proof of the wisdom of large steam reserves in metropolitan centers that ordinarily depend on water power.

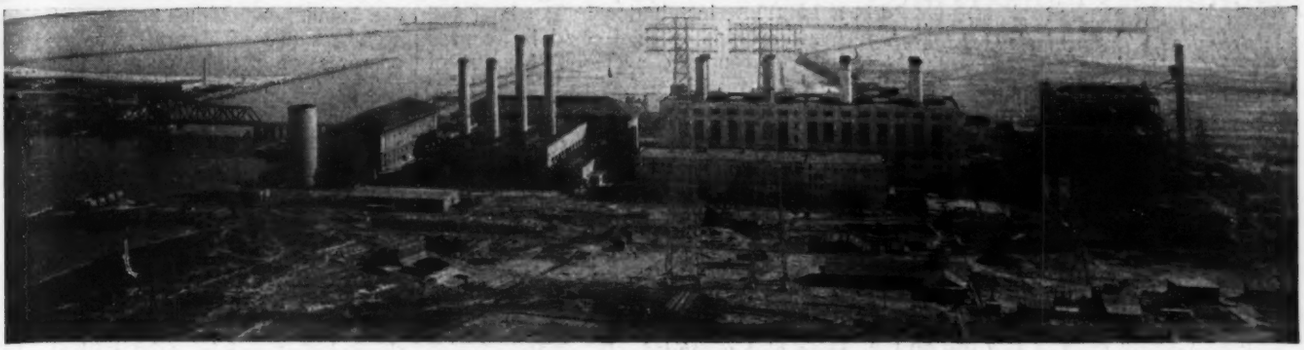
From the Southern California Edison Company the following specially prepared account of the first warnings of the disaster and the way in which the company came to the rescue has been received by the ELECTRICAL WORLD:

The first warning of the impending disaster reached the Edison company dispatcher's office at 11:58 p.m., March 12, when one of the company's 60-kv. lines between Saugus and Lancaster went out. Trouble developed at the Saugus substation, and the entire Saugus substation crew was called immediately, which undoubtedly saved the lives of the operators at this substation.



Center section of dam as it now appears

Where plant No. 2 stood—Generators still intact



Long Beach steam power house of Southern California Edison Company saves the day

At 12:02 a.m. both of Los Angeles City's 110-kv. lines went out. At 12:04 a.m., just two minutes later, the Edison company picked up the total city load. At 12:39½ a.m. one of the Edison 220-kv. Big Creek-Los Angeles lines short-circuited. At 12:41 a.m. the second of these lines followed suit.

Up to this time neither the city of Los Angeles nor the Edison dispatcher's office knew what was causing the difficulty. A little before 1 o'clock an assistant patrolman of the Edison company on duty near Saugus called the dispatcher's office over the regular telephone lines and told what had occurred. He had been caught in the edge of the onrushing waters, but managed to escape and reach a telephone so as to get the warning in. Immediately the Edison dispatchers sensed the danger which this onrushing flood offered to the cities and towns in Santa Clara Valley, and calls were put through for all Santa Clara Valley substations.

Casitas substation, just north of Ventura, was the first one in the line, and the story was relayed to the operator in charge with the request that he immediately take steps to notify the chief of police in every one of the cities and towns in the Santa Clara Valley and then notify the Edison district managers in the territory affected. This man called the operators in the Saticoy switching station and other stations throughout the valley, and the story of the impending danger was spread. Undoubtedly many lives were saved by this timely action on the part of the Edison company dispatchers.

City Orders Generator

Plans of the city of Los Angeles to restore its service are revealed by the fact that the Allis-Chalmers Manufacturing Company at Milwaukee has received a rush order for a generator, waterwheel and transformer to develop 30,000 hp. and to be placed in plant No. 1, located above the St. Francis Dam and not damaged by the flood. The equipment will be ready for shipment in about five months.

Dr. Elwood Mead, the Commissioner of Reclamation, has accepted the chairmanship of a special committee of engineers which will investigate the cause of the failure of the St. Francis Dam. The Secretary of the Interior has extended to Dr. Mead the necessary leave of absence.

Manufacturing Executives at N.E.M.A. Meeting

Executives of the Policies Division of the National Electrical Manufacturers' Association gathered at the Edgewater Beach Hotel, Chicago, for group and general meetings extending from Wednesday afternoon to Friday morning of last week. Vice-president Clarence L. Collens, who is president of the Reliance Electric & Engineering Company, presided. It was announced that the membership had increased since the last meeting in September from 285 to 310 companies engaged in various branches of electrical manufacture. A code of ethics and sound merchandising principles introduced by N. A. Wolcott, president of the Packard Electric Company, was approved and referred to the board of governors for adoption.

R. J. Russell, president of the Century Electric Company, presented an analysis of present practice among manufacturers in terms of payment, showing the wide diversity in the use of the cash discount both as to the size of the discount allowed and the period taken and also the demoralizing influence of loose methods in regulating payments for goods sold. In a paper on the subject of minimum standard of performance for electrical products, W. S. Rugg of the Westinghouse Electric & Manufacturing Company recommended a minimum standard of performance as one way in which an industry can well serve its customers. Such a standard would be obtained by striking a balance among all the involved elements, such as lowest cost of manufacturing and distribution, greatest adaptability to the purpose for which the apparatus is to be used, greatest durability, lowest cost of maintenance and lowest cost of power to operate it.

The meetings were largely given over to the discussion of various phases of the manufacturing problem, embracing costs and channels of distribution, the possibility of changes in tariff schedule and administration, the need for more comprehensive industry statistics and the purpose of the Electrical Industry Sales Conference.

It was announced during the sessions that eighteen sections of the N.E.M.A. are now regularly collecting statistics on various classes of products and that four more are about to start. The next meeting of the Policies Division will be held at Association Island from July 29 to Aug. 1.

Savings-Bank Bills Signed by Governor Smith

Governor Smith of New York on Wednesday approved the four bills introduced by the special legislative committee on savings-bank investments, commenting on their importance as he signed them. Among these bills is the one authorizing investments in the bonds of certain electric, gas and telephone companies whose passage by the Legislature was recorded in the Electrical World last week.

The New York Assembly on Tuesday night passed and sent to the Senate without debate the Sargent water-power bills which carry provisions designed to insure to the state an adequate financial return for whatever private water-power development takes place on the inland streams. The first of these bills provides for the appointment of a commission of three members to be named by the Governor, the Speaker of the Assembly and the President pro tempore of the Senate. The commission is authorized to hold hearings to determine what would be a fair return to the state from private power development on the inland streams. The second of the bills is designed to give protection to the Adirondack resorts chiefly through specifically forbidding the proposed Oxbow reservoir near Tupper Lake, a provision which has been particularly demanded by Saranac Lake and near-by communities.

The proposed commission is required to report to the Legislature what it believes to be a fair rate of return from the private power development. If the rate is approved by the next Legislature, the way will be opened for the development of approximately one-third of the undeveloped hydro-electric power in the state, it is asserted.

The Sargent bills were passed by the Senate in the last-hour rush before adjournment on Thursday and sent to the Governor. His approval, although hoped for, is not yet certain. A premature press report reprinted in these columns last week indicated wrongly that the bills had already been passed and signed.

Northwest Engineers Meet

Distribution, Transmission, Lightning and Cable Terminal Failures Chief Problems Discussed at Spokane Gathering

MEMBERS of the Engineering Section of the Northwest Electric Light and Power Association gathered for their fifth annual midwinter meeting in Spokane, Wash., March 8 and 9. The section, under Chairman O. L. LeFever, has had an active year, and a number of excellent papers were presented. One by M. T. Crawford on the overhead distribution network in Seattle dealt with the experience of the Puget Sound Power & Light Company with a common primary and secondary neutral system. Little trouble has been experienced with transformer outages due to cascading as long as the size of wire in the secondary network has not exceeded No. 4; on the contrary, better voltage regulation, greater economy and more reliable service have resulted, with little inductive interference with telephone service.

The work undertaken by A. O. Austin, Ohio Insulator Company, on high-voltage insulation and lighting was reviewed by H. V. Carpenter, Washington State College, who brought out the fact that Mr. Austin has shown greater economy and better insulator operating characteristics by the use of wooden poles, crossarms and pins and removal of the ground connection from pins than obtains where all-steel construction is used. An illustrated lecture on the Chelan development of the Washington Water Power Company was presented by the hydraulic power committee in which the advantages of the Wahlman gathering intake tube were brought out.

E. C. Stone, chairman Engineering National Section, held that the problem now before engineers of the industry is to secure more system capacity per dollar of investment and stressed the importance of the N.E.L.A. committees as a medium through which to work. A paper on lightning-arrester practice in the Northwest by Richard McKay of the apparatus committee showed little trouble from lightning when arresters are properly applied. The tendency is for bus as well as line protection. Discussion showed that protection resolves itself into a question of proper economic balance between line insulation, apparatus insulation and the cost of protection.

The most important contribution of the underground systems committee was the presentation of results of an investigation which disclosed the cause of failure in certain types of outdoor cable terminals. S. B. Clark showed that terminal failures experienced by one operating company were in large measure caused by internal flashovers caused by unfilled air spaces in vital parts of the terminal subjected to high voltage stresses and into which humid air is breathed. A paper on metal-tank mercury-arc rectifiers for 1,300-volt railway service by John Bankus indicated satisfactory operating results on a 1,500-kw. installation in Portland and greater economy than could be secured by synchronous converters. Success of gaseous rectifiers for railway service seems to presage a much wider application of this system of rectification and its extension to lower voltages.

Through the courtesy of the Washington Water Power Company those attending the meeting were afforded an opportunity to visit power plants and substations and other points of engineering interest in and around Spokane. Trips to the Lake Chelan development were also arranged.

Arc-Welded Steel Frame

General Electric Company's Use of This Method in an Addition, Nearly Complete, to Its Philadelphia Plant Described at Engineers' Meeting

BEFORE a meeting of the American Society of Civil Engineers held at the Engineers' Club, Philadelphia, on March 14 Prof. Frank P. McKibben described the welded steel-frame factory building now being completed by the General Electric Company as an addition to its new plant in Philadelphia.

Arc-welding a steel-frame building

The structure is approximately 140 ft. wide, 600 ft. long and 50 ft. high and is erected at Sixty-eighth Street and Elmwood Avenue, Philadelphia. Across the Elmwood Avenue end and connecting to an adjoining building is a high bay or transept spanned by seven of the new welded roof trusses, each having a span of about 72 ft. The main wing of the building has a crane bay over which are twenty of the new trusses, each having a span of about 58 ft. There is also a gallery in an adjacent wing, over which there are twenty welded trusses, each of about 80-ft. span.

The large trusses used to support the roof on the new building are of particular interest because they involve new ideas in truss design. Each truss consists of two parallel lengths of metal latticed together by a system of tension and compression members. The common practice was to construct the trusses with angle iron, but in the new truss the two parallel members or chords are made of H-beams, the tension members are of channel iron and the compression members are H-beams.

The General Electric Company, in order to determine the relative holding values of welded joints, conducted many tests on welded and riveted joints. In one series of tests welded specimens were made by the company and the actual tests were conducted under the direction of Prof. T. R. Lawson of the Rensselaer Polytechnic Institute, Troy, N. Y., in the laboratory of that institution. These tests showed that a $\frac{1}{4}$-in. fillet will stand a safe allowable load of 2,600 lb. per lineal inch, using four as a factor of safety. Corresponding values for $\frac{5}{16}$-in. and $\frac{3}{8}$-in. fillets were 2,900 lb. and 3,200 lb. A $\frac{3}{4}$-in. rivet, the standard size, is estimated to stand a shearing load of 4,500 lb.

In his talk at the Engineers' Club Professor McKibben said that the use of welding resulted in a considerable saving of steel and a consequent reduction in the cost of the steel frame, in the elimination of noise due to riveting and in promoting the electrical industry.

The majority of the welding was done with $\frac{3}{8}$-in. fillet welds, $\frac{5}{16}$-in fillets being used to some extent at various times. The work is being carried on by the U. G. I. Contracting Company of Philadelphia, general contractor. Harris & Richards, architects of Philadelphia, designed the structure.

Would Substitute Conferences for District Convention

Subject to the approval of the light and power companies of Minnesota, North Dakota and South Dakota, the executive committee of the North Central Electric Association, which is the geographic division of the National Electric Light Association comprising the three states named, has recommended that the annual convention be superseded by four conferences—accounting, commercial sales, engineering and managerial. This change has been contemplated for some time, and a try-out of two-day conferences was made last year in accounting, commercial sales and engineering. These three sessions drew an attendance of 309, and the response to the new plan was very favorable. Sectional meetings at various points in the district have also been well attended, more than 1,100 taking part. It has been suggested that the association conduct a convention only once every two or three years. A conference of executives and managers will be held at Breezy Point, near Pequot, Minn., June 15 and 16.

The South Dakota electrical conference of the North Central Electric Association was held March 21 at Sioux Falls with much success, speakers from Chicago, Minneapolis and Sioux Falls dealing with engineering and commercial subjects.

Purchases and Mergers

Washington Water Power Company Formally Taken Over by American Power & Light—Expansion in Pennsylvania and Other States

CONTROL of the Washington Water Power Company by the American Power & Light Company of New York was taken over at the annual meeting of the Washington Water Power Company at Spokane last week. Several of the former members of the board were retained, including the executive officers, President D. L. Huntington, General Manager M. W. Birkett and General Counsel Frank T. Post. Sidney Z. Mitchell, president Electric Bond & Share Company, New York, heads the list of trustees and the executive and finance committees. (See ELECTRICAL WORLD, Jan. 21, page 166.)

Applications have been heard before the Pennsylvania Public Service Commission from the Glen Rock Electric Light & Power Company for permission to acquire the East Hopewell Township Light, Heat & Power Company, the Cross Roads Light, Heat & Power Company and the Manheim Township Light, Heat & Power Company, and from the Edison Light & Power Company for permission to acquire the Chanceford Light, Heat & Power Company, the Winterstown Light, Heat & Power Company and the North Hopewell Township Light, Heat & Power Company. All the companies sought by the two would-be purchasers are "paper" concerns, and what is really sought is permission to extend lines over territory contiguous to that now served.

Purchase of seven smaller companies by the Scranton Electric Company has been approved by the Department of State at Harrisburg, Pa., following the Public Service Commission's sanction. The companies purchased are the Carbondale Township Electric Company, Clifford Township Electric Corporation, Greenfield Township Electric Corporation, Laflin Electric Company, Newton Township Electric Corporation, Ransom Township Electric Corporation and Scott Township Electric Corporation.

The St. Lawrence County Utilities, Inc., and the Antwerp Light & Power Company have made a joint application to the New York Public Service Commission for consent to the transfer of the works and system of the latter to the former. The New York Power & Light Corporation has made application to the Public Service Commission for authority to acquire 155 of the 160 outstanding shares of the common stock of the Ticonderoga Electric Light & Power Company. The petition states that the New York company and its subsidiary, the Port Henry Light & Power Company, operate in a territory contiguous to that served by the Ticonderoga company.

An unusual situation has developed as the result of the purchase of 54 per cent of the stock of the Hammond (N. Y.) Light & Power Company by the St. Lawrence County Utilities of Potsdam, N. Y., and of the minority interest by Michael Doyle of Rochester, representing the Oswegatchie Light & Power Company of Gouverneur, N. Y. The minority stockholders, it is reported, gained control of a meeting following the sale, elected the directors and indorsed an expansion program favored by Mr. Doyle, and so far their action has not been reversed.

The Western United Gas & Electric Company, Aurora, Ill., has been authorized to purchase the Western Public Service Company, serving communities along the Burlington Road.

The light and power system at North Lewisburg, Ohio, has been sold to Cleveland capitalists by Frank A. Jordan for $20,000. The purchasers have incorporated as the North Lewisburg Light & Power Company.

The Consumers' Public Service Company, a new corporation with headquarters in Brookfield, Mo., has purchased and merged several utility companies in northern Missouri, including the Browning-Purdin Electric Company, the Laclede Electric Company, the Powersville Electric Light & Power Company and the Rothville-Sumner Electric Company.

Negotiations for the purchase of the Harford County property of the Northern Maryland Power Company by the Consolidated Gas, Electric Light & Power Company of Baltimore have been held up until certain figures shall be verified. Consummation of the deal, however, is expected within a month, according to President H. A. Wagner of the Baltimore utility.

As the result of a unanimous town election, the Southern Public Utilities Company will take over operation of the Walnut Cove (N. C.) electric light plant on June 1.

The Northern States Power Company at Sioux Falls, S. D., has increased its offer of $7,500 for the Canistota (S. D.) municipal electric light and distribution system to $10,000, and the Council will again submit the proposal for sale of the plant at a special election in April.

Milton, Fla., is to vote soon on the ratification of the sale of the town plant to the Gulf Power Company.

Fort Collins, Colo., will probably hold an election on April 3 to decide whether the city shall own and operate its own electric and gas plants. Electricity is now supplied by the Public Service Company of Colorado.

Portland Merger Election Set for April 9

In response to the formal request to the Portland (Ore.) City Council to provide for a special election at which an ordinance will be submitted to the voters on the proposed sale of the Northwestern Electric Company to its competitor, the Portland Electric Power Company, the date of the election has been set as April 9. As a part of the ordinance a new residential schedule is offered to the people of Portland which will bring about an average reduction of 11 per cent in domestic rates. Reduced rates, according to officials, are contingent upon operating economies to be effected through the unification of the companies and will become effective only in the event that the proposal is approved by the voters. As a protection to the public against any increase in rates the ordinance contains a clause stipulating that no increase in rates shall be contemplated or requested during a period of five years. A promise is further made that, if the unification is approved, steps will be taken immediately to establish lower rates for commercial lighting and power and that the maximum rate for commercial lighting shall not exceed 5 cents per kilowatt-hour as against the present top rate of 7 cents.

Following is the new domestic schedule: First 38 kw.-hr. per month, 5 cents per kilowatt-hour; next 32 kw.-hr., 2.8 cents; excess, 1.9 cents. For an installation of 600 watts or less 38 kw.-hr. will be charged for at 5 cents per kilowatt-hour and one additional kilowatt-hour will be sold at 5 cents for each 30 watts of installation in excess of 600 watts. Lighting only will be considered in the determination of the demand. The minimum charge will be $1 per month for lighting customers and $2 per month for cooking and heating customers having a connected load in excess of 2 kw.

Illinois Men Convene

State Electric Association Takes Part in Two-Day Meeting at Springfield Embracing Three Utility Bodies—Street-Lighting Business a Topic

GOVERNMENT ownership was characterized as an attempt to transform the state into a benevolent Santa Claus, "doing everything for everybody at no cost to anybody," by Henry Swift Ives, vice-president of the Casualty Information Clearing House, Chicago, who addressed the opening session of a two-day annual convention of the Illinois State Electric, Gas and Street Railway associations held at Springfield on March 14 and 15. He warned the utility delegates that the "old feudal doctrine that the government should support the people" is having a remarkable revival in this country.

Further addresses and discussions in the two morning general sessions of the convention by J. P. Barnes, Oscar H. Fogg, B. J. Mullaney, George R. Jones, Mrs. Marc J. Fowler, Jay G. Mitchell, Charles N. Wheeler, F. S. Armstrong, E. R. Dillavou and others were devoted to considerations of public policy, domestic utilization of utility services, telling the utilities' story to the public, accident prevention and the terminable permit idea. The record of accomplishment of the Illinois Committee on Public Utility Information during the nine years of its life, presented by Mr. Mullaney, showed conclusively that such work is worth while.

The Illinois State Electric Association held its sessions on Wednesday and Thursday afternoons. The report of the industrial relations committee, by W. J. McPherson, summarized the better adjustment of this important factor. R. J. Malcolmson dealt with "Street Lighting as a Source of Revenue." His view of the possibilities of this class of business where there is aggressive sales effort brought out an animated discussion. The paper emphasized the necessity for high-intensity lighting since the fixed-investment charges on any installation are only slightly affected by lamp sizes.

The status of and market for residential refixturing was covered by R. G. Raymond. Methods used and results obtained from fixture sales campaigns by the Ohio Public Service Company and in Chicago by the Electric Association were detailed.

Prof. E. W. Lehmann, who is direc-

tor of the Illinois project on rural electrification, made his final report, presenting definite data on costs of equipment and energy. The view that rural electric business should be treated separately from other classes was taken by J. Paul Clayton, who pointed out that methods of distribution, rate forms, accounting practices and sales efforts for rural business are different from those for ordinary urban business. A paper by F. B. Sans on progress in connection with superpower transmission in Illinois closed the sessions.

The total convention registration, including all groups, was more than 800, and approximately that number attended the convention dinner, at which Colonel Sidney Storey spoke on the necessity for an American merchant marine.

Best Oklahoma Meeting

Manufacturers and Suppliers Have Exhibit—Local "Good-Will" Gatherings to Be Extended Because of Success at Okmulgee and Lawton

WHAT was declared the most successful convention in the history of the Oklahoma Utilities Association closed at Tulsa on March 15. Besides the events briefly noticed last week (page 573), notable addresses at the general sessions were made by Alexander Forward, managing director American Gas Association; E. K. Hall, vice-president American Telephone & Telegraph Company; J. W. Welsh, general secretary American Electric Railway Association, and others.

The importance of maintaining the public relations and public speaking program was emphasized by W. S. Vivian of Chicago, director of public relations, Middle West Utilities Company. H. S. Bennion, director of engineering of the National Electric Light Association, gave some interesting information on "Interstate Power."

Papers presented in the Electric Light and Power Division were on refrigeration, by R. W. Curran, Bartlesville; rural electrification, by Edwin Kurtz, A. and M. College, Stillwater, and L. S. Reagan, Oklahoma City; developing the small industrial load, by S. I. McElhoes, Oklahoma City; safety methods, by C. H. Meyer, Tulsa; developing power load in the oil fields, by O. A. Jennings, Oklahoma City; rates, by George Mills, Dallas, Tex., and decorative lighting, by A. E. Warner, Oklahoma City.

Five hundred and fifty persons attended the banquet and entertainment on March 14—200 more than last year. Congressman Eaton's address, in which he attacked tendencies to state socialism, as evidenced by endeavors to bring utility companies under public ownership, and defended the utility industries was well received.

Twenty manufacturers and suppliers had exhibits at the convention, almost the entire fifteenth floor of the Mayo Hotel being devoted to this purpose. Establishment of a safety, claims and accident prevention committee to operate within the Public Relations Division of the association was authorized by the executive board. This division announced that it will be more active during the coming year than ever and will continue and extend "good will" meetings like those held recently at Okmulgee and Lawton, where there was a larger registration of outsiders than of public utility men.

New officers to serve until March 14, 1929, are: President, L. W. Scherer, Yale, president of the United Telephone Corporation; first vice-president, H. L. Montgomery, Bartlesville; second vice-president, T. H. Steffens, Sand Springs; treasurer, W. R. Emerson, Oklahoma City; manager (re-elected), E. F. McKay, Oklahoma City. Frank J. Meyer, Oklahoma Gas & Electric Company, was elected chairman of the Electric Light and Power Division, and L. P. Arnold, Public Service Company of Oklahoma, chairman of the Public Relations Division.

Briefer News

PORT ANGELES, WASH., PLANS CITY POWER PLANT.—Port Angeles, Wash., has filed application for 650 sec.-ft. of water from the Elwha River for a proposed city power and light project capable of developing 10,000 hp. and to cost $750,000.

CENTRAL STATES ELECTRIC COMPANY TO BUILD 100 MILES OF LINE.—Besides increasing the capacity of its Iowa Falls and Armstrong stations, the Central States Electric Company of Cedar Rapids, Iowa, will this year, Vice-president John A. Reed announces, build 100 miles of 33,000-volt, three-phase line, extending from Havelock to Fenton, from Iowa Falls to Eldora, and from Blairsburg to Duncombe and Stratford.

TOKYO CENTRAL-STATION COMPANIES TO BE MERGED ON APRIL 1.—Announcement comes from Japan, where unrestrained competition has prevailed to a large degree in the electric light and power business, that the Tokyo Electric Light Company and the Tokyo Electric Power Company will be merged on April 1. This is regarded as a first and very important step toward establishing the industry in that country on the basis of regulated monopoly.

NORTHWESTERN ONTARIO WILL SOON HAVE 56,000 HP. ADDITIONAL AT SPRUCE FALLS.—Excellent progress on the hydro development of the Spruce Falls Power & Paper Company at Smoky Falls on the Mattagami River, 50 miles north of Kapuskasing, Ontario, is reported, and the plant may be completed by the middle of April. It comprises a power development of 75,000 hp., 50 miles of transmission line and the same length of standard-gage railway between the 600-ton mill and the power site. Four generating units will eventually be installed, of 18,750 hp. each, under a head of 114 ft. The present installation includes three of these.

SAN JUAN RIVER HAS POTENTIAL WATER POWER OF 280,000 HP.—According to the Geological Survey, the San Juan River, called the second largest tributary of the Colorado, has unused resources sufficient to sustain a large development in agriculture and water power. The present power demands are small and are supplied by less than 7,500 hp., generated in four plants. The undeveloped power resources consist of ten power sites capable of yielding, with storage, about 280,000 hp. The report was made by E. C. LaRue.

MOBILE DESIRES TO IMPROVE STREET LIGHTING.—Engineering estimates totaling approximately $270,000 have been compiled and submitted to the Board of City Commissioners of Mobile, Ala., on a proposed extensive ornamental "white-way" street-lighting system for the city. The plan embraced in the survey would require approximately 490 12-ft. standards and 825 10-ft. standards. It would equip practically all the principal streets of the business district with "white-way" lighting and would include about three miles on Government Street, a leading residential thoroughfare.

DUKE COMPANY PLANS STILL ANOTHER CATAWBA RIVER DEVELOPMENT.—With the approaching completion of the Duke Power Company's 56,000 hp. hydro-electric plant at Oxford Shoals, N. C.—the twelfth on the Catawba River—comes a report that the company has already begun preliminary work incident to still another plant on this stream. Details of the project have not been made public, but it is believed that the plant will rank with the largest yet constructed by the company. It will be built just above the Mountain Island plant, near Castonia, completed two or three years ago. No estimates of costs have been announced.

UPSTATE NEW YORK COMPANY PLANS SUBSTANTIAL CONSTRUCTION. — The New York State Gas & Electric Corporation expects to spend $1,672,418 for construction and improvements to its system during 1928. The program includes a 7,500-kw. turbine installation at Ithaca, a 33-kv. transmission line between Liberty and Jeffersonville, a waterwheel at Colliers, an extension from Mount Upton to Gilbertsville and Morris, a transmission line from Walton to Cannonsville and Hancock, substation and substation additions at Walton, Deposit and Hancock, and minor equipment at Delhi.

NEW KENTUCKY TRANSMISSION LINE COMPLETED.—The Kentucky Utilities Company placed in service on March 15 its new 66,000-volt, 36-mile, double-circuit, steel-tower transmission line connecting Morganfield and Earlington, in western Kentucky. The line, which

cost nearly $300,000, has transformer substations at both ends and took six months to build. It forms an important link in a transmission loop to be completed in the coming summer, which will include the Earlington, Graham and Paducah generating stations of the Kentucky Utilities and the Grand Tower and Muddy stations of the Central Illinois Public Service Company.

ELECTRIC DRILLS SEEK MORE OIL 7,600 FT. BENEATH SURFACE.—What is pronounced the most remarkable test yet made of the use of electricity in oil-well drilling is that of the Texas Oil & Land Company on land owned by the University of Texas in the Big Lake field. When the report was received this well was past the 7,600-ft. mark and was being sunk still deeper. But for the adaptability of electric motors in handling the drilling tools it would have been impossible to drill the well to so great a depth, it is asserted. The electric motors are so efficient that the tools can be raised, the bailer run twice and the tools run back on bottom in one hour and thirty minutes.

THREE-CORNERED AGREEMENT OVER DELCO-REMY SERVICE ADOPTED. — The difficulty noted on Feb. 11 (page 324) over additional power and standby service for the Delco-Remy plants at Anderson, Ind., which employ seven thousand persons, has been adjusted by a six-year contract with the Indiana General Service Company for all power in excess of what the municipal plant can furnish. The power company will build a 132-kv. transmission line to the east edge of the city and erect a substation, while Anderson will build lines from the corporation limits to the Delco-Remy plants and also to the municipal plant. Whenever the city takes energy from the Indiana General Service Company the latter will be repaid from the municipal plant.

MONTREAL INVESTIGATES POWER POSSIBILITIES OF AQUEDUCT AND OF GARBAGE INCINERATORS.—The possibility of utilizing the aqueduct in Montreal, where electric pumping has been substituted for steam, to furnish light and power is being investigated. The city spends annually more than $750,000 for electrical energy and the indicated saving is thought worth while. The aqueduct is about seven miles long and the installation of a city power system would not only provide power for it but also for the sewer department, street lighting and civic building. Engineers are also estimating the available power development from the combustion of garbage at incineration plants which the city expects to erect this year.

ILLUMINATING ENGINEERS OF THE WORLD TO TOUR AMERICAN CITIES.—An International Congress on Illumination, to bring together leaders in the field of lighting from all parts of the world, is to be held in the United States in September. The event will open on Sept. 7 with a tour by the foreign delegates to various American cities, will include the twenty-second annual convention of the Illuminating Engineering Society at Toronto on Sept. 17-20 and will close with the eighth session of the International Commission on Illumination, to be held at Saranac Inn, N. Y., from Sept. 22 to 28. The arrangements are being made under the auspices of the Illuminating Engineering Society and the United States National Committee of the International Commission on Illumination. John W. Lieb, vice-president New York Edison Company, is serving as chairman of the reception committee. Julius Daniels, Edison Electric Illuminating Company of Boston, is chairman of the executive committee in charge of arrangements.

SIXTY THOUSAND VISIT NEW ORLEANS ELECTRICAL EXPOSITION. — Almost sixty thousand persons visited the electrical exposition sponsored by the

Electrical League of New Orleans and held at the Delgado Trades School early this month. Many manufacturers and electrical companies had booths, and the lighting was an especially attractive feature. Credit for the success scored is due in large part to the arrangement committee, of which W. E. Clement, commercial manager New Orleans Public Service, Inc., was general chairman. The illustration shows the booth of the company just named.

APPLICATION TO MISSOURI COMMISSION FOR BAGNELL SITE TEMPORARILY WITHDRAWN. — The Missouri Hydro-Electric Power Company on March 13 withdrew for the present its application for an extension of the certificate of convenience and necessity granted it by the Missouri Public Service Commission two years ago to construct a dam and power plant on the Osage River near Bagnell. Protests against the project were made by residents of Camden and Benton Counties, and especially by citizens of the village of Linn Creek, which, it was said, would be obliterated. It was stated that the federal license issued to Walter Cravens, former head of the company in Deecmber, 1925, had been transferred to the company. The estimated cost of this project is $19,000,000, and, as stated on Feb. 18 (page 369), Stone & Webster and the Union Electric Light & Power Company may possibly become actively interested in it.

A.S.M.E.'s TENTATIVE PLAN FOR FUEL RESEARCH.—A preliminary plan for research in fuels, as approved by the main research committee of the American Society of Mechanical Engineers, has been issued. This research is to be carried on as one of the society's activities, and the chairman of the special committee having the research in charge—F. R. Wadleigh, 1 Broadway, New York—solicits suggestions and assistance from all interested. A booklet, "Research Activities," issued by the society, is available.

MUNICIPAL OWNERSHIP IN MISSOURI.—Voters of Kennett, in southern Missouri, with but nine dissenting votes, on March 14 decided to build and operate a municipal light and power plant and distribution system, although on the day before the election the Arkansas-Missouri Power Company, which has been serving the town, announced a substantial reduction in its rates. The town has three proposals under consideration, several plant-equipment concerns having offered to install equipment and accept payment out of the plant's profits if the town will furnish the building. Trenton, in the other end of the state, has a municipal plant under consideration, its estimates being based on the cost of the one in Chillicothe, Mo.

EXTENSION OF BUREAU OF STANDARDS' CONTROL OF WEIGHTS AND MEASURES OPPOSED.—The American Institute of Weights and Measures is out in opposition to a bill now before a committee of the House of Representatives and designed to empower the Bureau of Standards to approve or disapprove all weighing and measuring devices or mechanisms used in the country. The American Institute of Weights and Measures recommends that every one concerned take steps to inform himself regarding the provisions of this bill. It accuses the Bureau of Standards of seeking authority to police every conceivable kind of device in use for producing articles dimensioned in terms of the standards of weight and measure. Micrometers, gages and meters of every kind are mentioned among the apparatus which the protesters think would automatically be included in the provisions of the bill.

AMERICAN ELECTROCHEMICAL SOCIETY'S SPRING PROGRAM AT BRIDGEPORT. —Dr. George W. Vinal of the Bureau of Standards will be in charge of the first session of the American Electrochemical Society's spring meeting at Bridgeport, Conn., on April 26-28, the symposium subject being "Chemical Production of Electricity" and covering electrolytic rectifiers, storage batteries, gas cells, dry cells and standard cells. The evening will be devoted to an illustrated lecture on the "Refraction of X-Rays in Elements and Compounds,"

by Prof. Bergen Davis of Columbia University. On Friday morning a discussion on industrial electric heating, held jointly with the National Electric Light Association, will be participated in by R. M. Keeney, John L. Christie, R. E. Talley and others. A new film on "Electric Heat in Industry" will be presented. Dr. B. D. Saklatwalla, chairman of the electrothermic division, will preside at an informal round-table discussion on refractories for electric brass melting. Saturday morning's session, in charge of Prof. E. M. Baker, will deal with the plating of silver, nickel, brass and chromium.

Coming Meetings

[A complete directory of electrical associations, with their secretaries, is published in the first issue of every volume. For latest list see ELECTRICAL WORLD for Jan. 7, page 80.]

Southwestern Division, N. E. L. A.—Edgewater Gulf Hotel, Biloxi, Miss., April 3-5. S. J. Ballinger, San Antonio Public Service Company, San Antonio, Tex.

Nebraska Section, N. E. L. A.—Omaha, April 4 and 5. T. E. Browne, 1527 Sharpe Bldg., Lincoln.

Southeastern Division, N. E. L. A.—Miami, Fla., April 11-14. C. M. Kilian, 207 Bona Allen Bldg., Atlanta.

American Institute of Electrical Engineers — Baltimore regional meeting, April 17-19; New Haven regional meeting, May 9-11; national convention, Cosmopolitan Hotel, Denver, June 25-29. F. L. Hutchinson, 33 West 39th St., New York.

American Welding Society—Engineering Societies Building, New York, April 25-27. M. M. Kelly, 29 West 39th St., New York.

American Electrochemical Society—Bridgeport, Conn., April 26-28. C. G. Fink, Columbia University, New York.

Missouri Association of Public Utilities—Jefferson City, April 26-28. F. D. Beardslee, 315 North Twelfth St., St. Louis.

Southwestern Public Service Association—Dallas, Tex., May 2-5. E. N. Willis, 403 Slaughter Bldg., Dallas.

Middle West Division, N. E. L. A.—Hotel Statler, St. Louis, May 9-11. T. A. Browne, 1519 O St., Lincoln, Neb.

American Society of Mechanical Engineers—Pittsburgh, May 14-17. Calvin W. Rice, 29 West 39th St., New York.

National Electric Light Association—Atlantic City, June 4-8. P. S. Clapp, 420 Lexington Ave., New York.

American Association of Engineers—Hotel Hussman, El Paso, Tex., June 4-6. M. E. McIver, 63 E. Adams St., Chicago.

Electrical Supply Jobbers' Association—The Homestead, Hot Springs, Va., June 5-8. E. Donald Tolles, 165 Broadway, New York.

National Electrical Manufacturers' Association—The Homestead, Hot Springs, Va., June 11-15. S. N. Clarkson, 420 Lexington Ave., New York.

Pacific Coast Division, N.E.L.A.—Hotel Huntington, Pasadena, Cal., June 12-15. S. H. Taylor, 447 Sutter St., San Francisco.

Georgia Electrical Association—Savannah, June 14 and 15. J. J. McDonough, Georgia Power Co., Dublin, Ga.

Northwest Division, N.E.L.A.—Portland, Ore., June 19-22. B. Snow, 1208 Spalding Bldg., Portland, Ore.

Canadian Electrical Association—SS. "Richelieu" from Montreal to Saguenay and return, June 20-23. H. M. Lyster, 712 Power Bldg., Montreal.

Commission Rulings

CONDEMNATION OF LAND BY PUBLIC UTILITY INCLUDES COAL AND FIRECLAY BENEATH IT.—The Duquesne Light Company in condemning a parcel of ground on which to erect a substation was refused permission by the owner to acquire coal and fireclay underlying it. In view of the danger of subsidence of the plant if the underlying strata were removed, the company appealed to the Public Service Commission of Pennsylvania, which sustained its claim to the subsurface as well as the surface of the plot.

NEBRASKA COMMISSION LIMITS BOND ISSUE.—Passing on an application from the Central West Public Service Company of Nebraska for approval of an issue of 6 per cent 30-year bonds in the sum of $500,000, the Nebraska State Railway Commission holds that no bonds should be issued in excess of 75 per cent of the present value of the property offered as security and that in ascertaining the basis of such valuation there must be eliminated the working capital and going-concern value as well as any value placed on a water right acquired by purchase. It, therefore, declined to approve any issue in excess of $400,000. All the company's stock is owned by the Central West of Delaware. None of the bonds is to be sold to the public, but they will be substituted for stock now used as collateral for a mortgage of the parent company.

GEORGIA COMMISSION ON SUPREME COURT VALUATION DICTA AND ON COMBINATION COMPANIES.—In handing down a decision in a street-railway fare dispute involving the Georgia Power Company, the Public Service Commission of Georgia said: "The Supreme Court of the United States, to our mind, has not been as definite in prescribing rules as a guide for arriving at a fair value as a proper rate base as we believe should have been the case. However, considering its expressions on this subject as a whole, it is very clear that it leans more to the reproduction-cost theory than to any other method. It is our belief that a strict adherence to the reproduction-cost theory would not be best for the company or the citizens it serves. Conditions could happen, as they have happened in the past, which to apply to such a method would work disaster for the company as well as hardship on the public. Such a theory if applied in the last half of 1914, 1915 and 1916 would have bankrupted most of the companies throughout the country. . . . The commission has consistently held that where different classes of utility service are being rendered by one company, as far as practicable these properties should be segregated and the patrons of each class should bear their part of the burden of producing a return on the fair value of such property as is devoted to their use. To do otherwise would have the effect of creating discriminations between the different classes of patrons of the company. In the instant case it is true that many car riders do not use electric light or gas, whereas, on the other hand, many patrons of the gas and electric departments rarely if ever use the street-car service. It therefore follows that if the street-railway department is not earning a reasonable return on the fair value of its property, it would be a discrimination and unfair to the users of gas and electricity to require them to pay excessive rates to make up losses in the railway department. . . . If the street-railway property is to be treated in conjunction with the gas and light and power property, people throughout the state would be called upon to contribute to the support of the street-railway property, although comparatively few would ever have need for its use. Such a theory is fundamentally unsound."

PETITION BY CONSUMERS FOR INCREASED MONTHLY CHARGE DISMISSED.—The Indiana Public Service Commission has dismissed a petition from most of the customers of the Madison Light & Power Company asking that the minimum monthly charge be increased as an offset to a reduced lighting rate offered by the company. The commission said that the expense of the hearing required by law would be greater than the relative advantage that the customers were seeking.

Recent Court Decisions

RAILROAD FOUND LIABLE TO POWER COMPANY FOR BRIDGE CONSTRUCTED BY LATTER.—The United States Court at Charlotte, N. C., has decided that the Southern Railway owes the Blue Ridge Power Company $260,000 as reimbursement for expenses growing out of the construction of a bridge across Green River just above Saluda on a division of the Southern Railway. The power company, the decision explains, replaced a wooden trestle by a concrete bridge after it had asked for permission to construct a dam that would end the usefulness of the former trestle. The court found that the new bridge had benefited both companies equally and that the railway should reimburse the power company. Appeal will be taken.

UTILITY CONFINED BY STATE COMMISSION TO CERTAIN PART OF DIVIDED TERRITORY NOT DEPRIVED OF PROPERTY WITHOUT DUE PROCESS OF LAW.—In sustaining the decision of the New Jersey Board of Public Utility Commissioners fixing a territorial boundary in the borough of Spring Lake for the observance of rival light and power companies (ELECTRICAL WORLD, Feb. 18, page 374), the New Jersey Supreme Court said (Eastern New Jersey Power Company vs. Board) that it could find no merit in the contention that the order deprived the plaintiff of property without due process of law. "It is manifest," said the court, "that an electric light company which undertakes to furnish a municipality with lighting for its streets or public buildings and enters into a contract with such municipality, for either a short or long term of years, to that end necessarily takes into consideration the cost of furnishing adequate equipment for the purpose designed and that a time will come when the term of the contract will expire and the municipality may not see fit to renew the contract. . . . Neither of the companies has a right in perpetuity to furnish the electric lighting for the borough. . . . We can discern nothing in the order of the board which attempts to do anything more than to regulate how the two electric light companies shall exercise their franchises." (140 At. 258.)*

*The left-hand numbers refer to the volume and the right-hand numbers to the page of the National Reporter System.

News About Men of the Industry

C. W. WALLACE has been elected a director of the Toledo Edison Company.

J. E. WEBSTER has been appointed chief plant engineer of the Westinghouse Electric & Manufacturing Company at East Pittsburgh, Pa.

G. D. HORNE, district operating supervisor of the Central Hudson Gas & Electric Company at Beacon, N. Y., has been transferred to Poughkeepsie as division engineer.

J. M. BENNETT has been appointed manager of the department of public relations recently organized by the Philadelphia Electric Company for the handling of all matters relating to publicity and advertising.

P. C. BROOKS, president of E. & T. Fairbanks & Company and vice-president of the Canadian Fairbanks-Morse Company, Ltd., has been made a vice-president of Fairbanks, Morse & Company, Chicago.

SEBASTIAN L. DE FERRANTI, past-president of the Institution of Electrical Engineers of Great Britain, a pioneer in high-tension transmission and well known in this country and throughout Europe, has been elected a fellow of University College, London.

H. C. BLACKWELL, president of the Union Gas & Electric Company, Cincinnati, has been named chairman of the Cincinnati Safety Committee organized by the Industrial Commission of Ohio. Mr. Blackwell has long been active in civic affairs in Cincinnati, at the present time being president of the Cincinnati Chamber of Commerce.

LEWIS BUCKLEY STILLWELL of New York has been re-elected chairman of the Engineering Foundation, the research organization of the national engineering societies. Mr. Stillwell, who enters upon his fourth term, is past-president of the American Institute of Electrical Engineers and the American Institute of Consulting Engineers. He is a native of Pennsylvania and a graduate of Lehigh University.

FRANK MILHOLLAN, chairman of the Board of Railroad Commissioners of North Dakota, has resigned, effective April 1, to become president and general manager of the Central West Public Service Company. Ben Larkin, who has been a member of the board for more than two years, has been selected by Governor Sorlie to succeed Mr. Milhollan.

EDWARD B. MYERS, formerly assistant to J. T. Hutchings, vice-president in charge of engineering development of the United Gas Improvement Company, Philadelphia, has been named assistant to the president. Mr. Myers has been associated with the U.G.I. or its subsidiaries for 24 years, starting as a cadet engineer with the city district of the Philadelphia Gas Works in 1904. In 1911 he became associated with the engineering department of the Northern Indiana Gas & Electric Company, South Bend, Ind., returning to Philadelphia two years later.

Ballard Now President of Southern California Edison

Russell H. Ballard, executive vice-president and general manager of the Southern California Edison Company for the past eight years, was elected president of that company at the recent meeting of the board of directors, in succession to John B. Miller, who retains the chairmanship of the board. The selection of Mr. Ballard is the logical and expected result of his services to the company in the years during which it has grown from the status of

R. H. Ballard

a comparatively small organization exploiting the water-power resources of southern California to one of the greatest metropolitan central stations in the land, with immense steam plants supplementing its hydro installations and with reserve steam equipment capable of picking up the 93,000-kw. load dropped by the municipal plants in the recent disaster. With experience in commercial and financial work for power companies in the East, South, Middle West and Mountain States, Mr. Ballard became auditor of the Southern California Edison Company in 1904 and progressed steadily to the posts of assistant general manager, vice-president and assistant general manager, and vice-president and general manager. The last-named office he assumed in 1920.

Mr. Ballard's sphere, however, is not merely territorial. His election to the presidency of the National Electric Light Association in 1919 brought him into national prominence in the light and power world, and the outstanding services he rendered during his occupancy of that office have had lasting results. With the able assistance of M. H. Aylesworth, whom he installed as executive manager, he remodeled the structure of the association, giving it the form it still retains. By extensive speaking tours and participation in the conventions of the geographic divisions he reawakened the interest of industry executives in association activities, and the methods adopted in his term are still in favor at headquarters Mr. Ballard's own interest and participation in national work continue unabated.

D. B. RANNO has been named superintendent of the Schuylkill division of the Philadelphia Suburban-Counties Gas & Electric Company with headquarters at Norristown and R. R. DANIELS has been appointed superintendent of electric production of the Schuylkill division.

JOHN F. CARNEY has resigned as treasurer of the Utica (N. Y.) Gas & Electric Company after 26 years of service to become affiliated with Stone, Seymour & Company, Inc., investment brokers of New York. Mr. Carney will continue to reside at Utica.

LEE J. RUF has been appointed power plant superintendent of the Nebraska Power Company to succeed the late Edward McDonald. Mr. Ruf formerly was identified with the Omaha Electric Light & Power Company before that property was taken over by the Nebraska Power Company.

J. M. FLANIGEN, who was appointed division superintendent of the Georgia Power Company in Rome last December, has been recently transferred to the company's office in Atlanta. Mr. Flanigen was formerly connected with the Alliance division of the Ohio Public Service Company.

M. H. MONTROSS has been appointed general superintendent of the Wisconsin Valley Electric Company, Wausau, Wis. Mr. Montross was formely divisional manager at Stevens Point and prior to his connection with the Wisconsin Valley Electric Company he was associated with the Gary (Ind.) Heat, Light & Power Company and the Toledo Edison Company.

RICHARD LINCOLN has been appointed superintendent of the appliance department of the Edison Electric Illuminating Company of Boston, succeeding C. Ernest Greenwood, who recently resigned to become commercial manager of the National Electric Light Association. Mr. Lincoln's early career began in the electric railway construction field in Massachusetts and Virginia. He entered the collection department of the Boston Edison Company in 1909, was transferred to the sales department in 1916 and for three years was in charge of merchandise sales in the Framingham district. In 1919 he was promoted to be assistant superintendent of the appliance department, and will now be in charge

of all merchandising activities of the company. He is a past chairman of the merchandising bureau of the Commercial Section, New England Division, N.E.L.A.

W. C. GILMAN, formerly connected with the commercial department of the Central Hudson Gas & Electric Company, Poughkeepsie, N. Y., is now identified with the Carolina Power & Light Company at Raleigh, N. C.

ROBERT J. DENEEN and FREDERIC ATTWOOD were elected vice-presidents of the Ohio Brass Company at a meeting of the board of directors held Feb. 7, 1928. Mr. Deneen is in charge of the company's sales activities in the Chicago district, while Mr. Attwood is in New York in charge of the Eastern sales district.

ROBERT W. PURCHAS, formerly purchasing agent for the Northern States Power Company in Minneapolis, has been appointed assistant to Vice-President H. W. Fuller, head of the engineering and construction department of the Byllesby Engineering & Management Corporation, Chicago. Mr. Purchas served as purchasing agent of the Northern States company for eight years.

R. H. DENMAN has been assigned to the Albany district of the New York Power & Light Corporation in the capacity of rural expert. Mr. Denman's duties will include the extending of electrical service on the farms in the Albany district. Mr. Denman is a graduate of Cornell University in agricultural engineering.

A. E. KAISER, who has been associated with the Westinghouse Electric & Manufacturing Company since 1895, has been appointed director of production for all works. During his period of service with the company he had a wide range of experience. After serving in various departments, he was appointed assistant director of production in 1912 and in 1919 he was promoted to be director of production of the East Pittsburgh works. Later he was made assistant works manager of the East Pittsburgh works.

GUY P. NORTON, a vice-president of the Miller Company, Meriden, Conn., was elected a director of that company at a meeting of the stockholders held March 8. Mr. Norton first became engaged in the manufacture of lighting fixtures in 1898. He helped perfect the first Duplex-a-lite organization, which became the Duplex Lighting Works of the General Electric Company in 1918. In 1924 this company was sold to the Miller Company and a year later Mr. Norton was made a vice-president of the company and placed in charge of Duplex-a-lite sales.

LEON M. BROCKWAY has affiliated himself with the New England Power System, Worcester, Mass., where he will co-ordinate the office and field engineering with the hydraulic development construction work. Seventeen years ago Mr. Brockway was identified with the New England system as resident engineer on the Shelburne Falls Development, but he left in 1913 to enter the employ of the Electric Bond & Share Company. Subsequent connections followed with the Ontario Power Company, the Power Construction Company, the Atlantic Loading Company, and Conway & Reid, general contractors, before he returned to the New England Power System.

E. S. ZUCK, formerly rate engineer of the Penn-Ohio System, is now power engineer of the United Gas Improvement Company, Philadelphia. Mr. Zuck's resignation brought to a close an association which covered a period of nine years, during which he served as power salesman, power sales engineer and finally as rate engineer. Before affiliating himself with the Penn-Ohio System Mr. Zuck had been connected with the Western Electric Company at Cleveland, the Electric Furnace Company at Salem and the Westinghouse Electric & Manufacturing Company at East Pittsburgh.

EARL L. CARTER has resigned as chief engineer of the Indiana Public Service Commission effective April 1, in order to enter private consulting work. In his position as engineer for the commission, one of his principal duties was to fix valuations of utilities for rate-making purposes. He entered the service of the commission in 1917 as assistant engineer and became chief engineer six years ago. He graduated from Purdue University in 1914 and received a master's degree in 1918. HARRY V. WENGER, formerly a member of the engineering staff of the commission, has been selected as Mr. Carter's successor. Mr. Wenger took a position with the commission in 1917 and also is a graduate of Purdue. He served on the commission engineering staff about three and one-half years. He left in 1923 after having been elected chief engineer of the railroad commission of South Dakota. Later he returned to Indianapolis and has engaged in private engineering work since that time.

Obituary

R. D. PIKE, general purchasing agent for the Pennsylvania-Ohio Power & Light Company, died at his home in Youngstown, Ohio, March 12. Mr. Pike had been with the company for fourteen years. He was 44 years of age.

CLIFTON H. DWINNELL, president of the First National Bank of Boston, died at his residence in that city March 13. He was 54 years of age and was graduated in electrical engineering in 1894 from the Worcester Polytechnic Institute, of which corporation he was a member.

DR. THOMAS B. FREAS, noted inventor and professor of chemistry at Columbia University, New York, died at Lenox Hill Hospital, after a short illness, March 15. Professor Freas was recognized as an authority on thermodynamics and had invented thermostats, ovens, ventilating apparatus and other laboratory necessities. He was a member of the American Electrochemical Society, the American Association for the Advancement of Science and other technical societies.

L. W. LLEWELLYN, president of the Walsh & Weidner Boiler Company, Chattanooga, Tenn., died March 18. Mr. Llewellyn had been incapacitated, due to heart trouble, since August, 1926. Besides being president of the Walsh & Weidner company he was also president of the Chattanooga Implement Manufacturing Corporation, treasurer of the Provident Life Insurance Company of Chattanooga and a member of the board of directors of a number of prominent enterprises around Chattanooga.

CONRAD HUBERT, chairman of the board of directors of the Yale Electric Corporation, New York, died March 14 at Cannes, France, in his seventieth year. Mr. Hubert organized the Ever-Ready Battery Company and held the presidency prior to the sale of the business to the National Carbon Company, about ten years ago. He subsequently purchased a majority of the stock of the Yale Electric Corporation, which manufactures flashlights and electric batteries for automobiles and radios. Mr. Hubert was interested in other industrial enterprises.

RALPH BLAKEMAN, manager of the Public Service Company of Colorado at Louisville, Colo., died suddenly at Windsor, Colo., Feb. 29.

ALBERT W. FLOR, who had been associated with the Electric Bond & Share Company for the past fourteen years, died Feb. 6 in his 42d year. After extensive experience in the government service, Mr. Flor joined the Utah Power & Light Company in Salt Lake City, previous to removing to New York. Among the executives whom he assisted were C. E. Groesbeck, E. K. Hall and F. B. Odlum.

SAMUEL F. MORAN, well known public utilities lawyer, died March 20 at St. Vincent's Hospital, New York, of chronic intestinal nephritis. Mr. Moran was admitted to the New York bar in 1903 and was assistant corporation counsel of Buffalo from 1906 to 1909. For many years he specialized in public utility law. Among the companies for which he was attorney are the Brooklyn Edison Company, the Kings County Lighting Company, the Cohoes Power & Light Corporation and the Citizens Water Supply Company of Newtown, New York. In 1919 he had charge of the merger of the electric corporations heretofore operating in Brooklyn which formed the Brooklyn Edison Company and since that time he had represented that corporation in all proceedings involved in stock and bond issues. Mr. Moran was 53 years of age.

Financial and Statistical News

Keen Investment Demand Stocks at New High Levels Fewer New Issues Sold

KEEN investment demand for public utility securities, combined with a sharp reduction in new issues, has resulted in a smaller visible supply of these securities. New power and light issues are now running between 40 and 50 per cent below last year. Another factor in the situation is the passage of the savings bank investment act in New York State. In addition to the actual legalization of a large volume of issues, the act will undoubtedly affect the trend of legislation elsewhere, in some degree at least.

The market for power and light securities has been exceedingly firm during the past few days. Averages are now at new high levels and the trend is distinctly upward. During the past week Edison of Boston went up fourteen points, to 272; Pacific Gas & Electric rose thirteen points, to 192; Public Service of New Jersey reached a new high of 138, and Southeastern Power & Light a new high of 47½; North American common reached a high of 67, and Electric Investors a high for the present movement of 48. These are only a few examples of the price rises in common stocks. A number of preferred issues have made substantial gains also. Buying of these issues by investment trusts is reported to be unusually active.

Company Reports

Name of Company	Gross Earnings Twelve Months Ended Jan. 31 1928	1927
American Power & Light subs.*	$62,786,765	$59,411,694
American Wtr. Wks. & Elec.	48,866,582	45,790,401
Idaho Power*	3,146,573	2,869,474
Kansas City Power & Lt.*	12,502,403	10,877,859
Kansas City Power & Lt.	12,667,634	10,955,810
New Orleans Public Service, Inc.*	18,442,108	17,624,514
Public Service Company of New Hampshire & subs.	3,631,593	3,469,173

* Twelve months ended Dec. 31, 1927.

North Carolina Developments in 1928

According to a recent statement of the Department of Conservation and Development of North Carolina new hydro developments totaling 295,000 hp. are now under construction. It is rumored that one of the large power companies will construct a 100,000-hp. steam station during the year. The Carolina Power & Light Company expects to begin construction on 110,000-volt transmission lines from Sanford to Cape Fear Station (10.7 miles), from Norwood to connect with existing lines (16 miles), from Canton to Greenville (55 miles), from Canton to Asheville (20 miles) and from Moncure to Sanford (37 miles), a total of 138.7 miles. This company completed during the present year the first 132,000-volt line in the state, leading from Roxboro to Danville, Va. The Virginia Electric & Power Company has planned to construct 32 miles of 33,000-volt lines during the year in the northeastern part of the state.

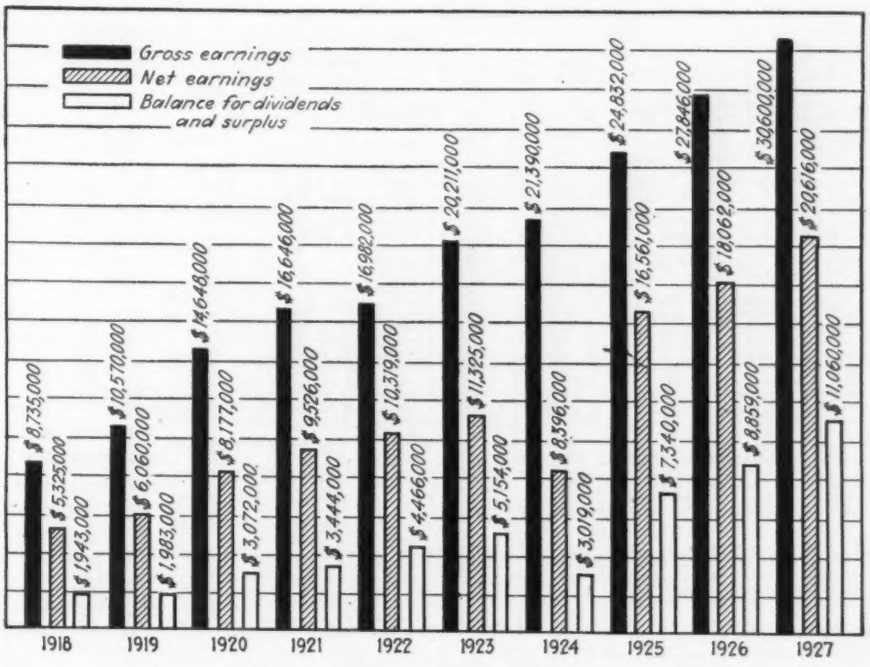
It is probable that during the year one or more of the larger municipal steam plants in the east will pass into the control of private interests, and this in turn will probably lead to new high-voltage lines being built in that section.

Altogether 1928 promises to be a year of considerable activity in power development in the state, and the ever-increasing power demand of new industries and expansion of existing activities will continue to be met by added power facilities adequate to supply whatever requirement exists.

Southern California Edison Reports Prosperous Year

IN SPITE of the reduction in lighting rates, which had been in force during the last six months of 1927, gross earnings of the Southern California Edison Company totaled $30,600,637, an increase of 9.9 per cent over the preceding year, when gross earnings amounted to $27,846,518. Net earnings amounted to $20,615,686, an increase of 14 per cent, and were equivalent to 3.54 times annual interest requirements. The coupling of these financial figures with the operating statistics makes a picture which reveals the satisfactory results of the year's operations. Sales of electric energy aggregated 1,877,204,517 kw.-hr. The maximum demand of over 600,000 hp. exceeded all previous records. Due to abundant water, favorable fuel costs and economies in operation, a reduction of $390,429, or 5.3 per cent, was effected in operating expenses. Taxes paid to federal, state and local governments amounted to $3,076,252. According to the report under review the year was also noteworthy with respect to the additional load connected, which aggregated 218,417 hp., the greatest amount of load taken on the lines in any twelve-month period of the company's history.

The company's financing program during the year included the sale in January of an additional issue of 25-year refunding mortgage bonds amounting to $15,000,000 and the offering in September of refunding mortgage 25-year bonds amounting to $30,000,000. Part of the proceeds of the first issue was used to retire outstanding notes and maturing debentures and proceeds from the second issue provided funds for the retirement of 6 per cent refunding mortgage bonds due in 1943. As a result of this new financing the company effected a considerable annual saving in fixed charges and materially improved the credit position of its subsequent bond issues. At the present time, in addition



Southern California Edison earnings show substantial gain

to the 5's of 1951 and 5's of 1952 mentioned above, the funded debt includes general and refunding mortgage bonds due Feb. 1, 1944, paying 5 per cent interest, amounting to $10,000,000, and 5½ per cent interest, amounting to $10,225,000. Also there are outstanding general mortgage 5 per cent 30-year gold bonds, due Nov. 1, 1939, totaling $13,360,000. Underlying bonds complete the set-up with a total of $15,412,700. The entire funded debt amounts to $134,971,700. The year closed with no floating debt against the company and with $5,023,599 cash on hand and in banks. Total assets as of Dec. 31, 1927, amounted to $309,837,988, an increase of $41,630,345 during the year.

Since 1917 the company's junior financing has been accomplished principally through the sale of its capital stocks to its consumers and the local public. At the close of the year 1927 individual stockholders numbered 114,150, with holdings averaging 50.3 shares each. The adoption of this customer-ownership plan, together with voluntary reductions in rates, is largely responsible for the cordial relations existing between the company and its customers. The trend of maximum rates for energy since 1920 is shown in the accompanying table.

	Cents Per Kw.-Hr.
1920	10.16
1921	9
1922	7.92
1923	6.5
1927	5.6

In closing the report, John B. Miller, president, says: "The company commands a strong financial position in the credit market and enjoys the confidence and support of the public in its territory. Physical properties are in excellent condition, covered by insurance against fire, earthquake, casualty and other contingencies, and proper provision has been made for depreciation and replacements."

AMERICAN SUPERPOWER INCREASES STOCK.—At a general meeting of stockholders of the American Superpower Corporation held March 9 an increase in the class A stock from 600,000 to 1,000,000 shares was authorized, as well as an increase in first preferred stock from 200,000 to 400,000 shares.

Bonds Called in March

Among the securities of electric light and power companies called for payment in advance of maturity are the following:

Issue	Due	Amount
Toledo Edison, 7s	1941	$13,500,000
Ohio Power, 6s	1953	10,000,000
Western States Gas & Elec., 6s	1947	8,850,000
Western States Gas & Elec., 6s	1937	5,000,000
National Electric Power, 5s	1945	8,662,500
Pennsylvania Water & Power, 5½s	1953	3,000,000
Holtwood Power, 6s	1954	2,750,000
Queensborough Gas & Elec., 6s	1953	2,000,000
Coast Valley Gas & Electric, 6s	1952	1,813,000
Quincy Gas, Elec. & Heating, 5s	1935	1,400,000
Eastern Wisconsin Electric, 5s	1947	1,024,500
Western Pwr. Lt. & Tele. 6½s	1947	1,000,000
Northeastern Iowa Power, 6s	1929	800,500
Northeastern Iowa Power, 5s	1929	300,000
Ottawa Light, Heat & Power, 6s	1928	650,000
Central States Power & Lt., 5½s	1953	250,000
Minnesota Elec. Distributing, 7s	1928	182,000
Public Service of N. J., 6s	1944	19,595,000
Public Service of N. J., 5½s	1956	15,000,000
Interstate Public Service, 6s	1948	8,551,900
Interstate Public Service, 5½s	1950	2,838,500
Central States Electric, 6s	1945	9,691,000
Beloit Water, Gas & Electric, 5s*	1937	30,000
Sandusky Gas & Electric, 5s*	1945	13,000

* Not entire issues.

Stock Quotations of Electric Light and Power and Manufacturing Companies

(Prices on New York stock market unless otherwise noted. Unless otherwise noted the par, stated, or preference value of stock is $100.)

Companies	Bid Price Tuesday March 20	Low 1928	High 1928
ABITIBI PWR. & PAPER, com., new — no par	b 80	72	81
Ala. Pwr., $7 com. pf.—no par	113½	114½	115½
Allis-Chalmers Mfg., 6% com.	120½	115½	125
Aluminum Co. of Amer., com.	126	120	136
Aluminum Co. of Amer., 6% pf.	b107½	105½	108½
Amer. & Foreign Pwr., 7% pf.—no par	106½	105½	108½
Amer. & Foreign Pwr., com.—no par	25	22½	27½
Amer. Bosch Magneto, com.—no par	22½	15½	23
Amer. Brown Boveri Elec.†	15½	10	18
Amer. Brown Boveri Elec., pf. $7	55	46½	63
Amer. Gas & Elec., 6% pf.—no par	108½	106½	109
Amer. Gas & Elec., com. †—no par	139½	117½	145
Amer. Lt. & Trac., 6% pf.	113	116	120
Amer. Lt. & Trac., new com.	19½	170	193½
Amer. Pwr. & Lt., 6% pf.	105½	104	109½
Amer. Pwr. & Lt., com. †—no par	81½	62½	83
Amer. Pub. Serv., 7% pf.	a100	99	101
Amer. Pub. Serv., com. †	b 70	70	75
Amer. Pub. Utilities, 7% ptc. pf.	94	90	95
Amer. Pub. Utilities, 7% pr. pf.	99	94	101
Amer. Pub. Utilities, com.	b 60	60	65
Amer. States Sec., A	a 6½	4	6½
Amer. States Sec., B	a 6½	4½	6½
Amer. Superpwr., 6% ptc pf.—25	m 30½	28½	30½
Amer. Superpwr., 6% 1st pf.	f 102½	....	....
Amer. Sup. pwr., Class A†—no par	40½	37	41½
Amer. Sup'pwr., Class B†—no par	42½	37½	43
Amer. Wtr. Wks. & Elec., 6% pf.	b102½	101½	105
Amer. W.W. & E., com. new—no par	60½	52½	61
Anaconda Copper cap. $3	55½	53½	59½
Appalachian Electric Pwr., 7% pf.	107½	108½	110
Arkansas Pwr., & Lt. 7% pf.	107½	108	109½
Assoc. Gas & Elec., $3.50—50	54	....	....
Assoc. Gas & Elec., pf.—$6—no par	95	96	98½
Assoc. G. & E., Class A, 10—no par	48½	47	51½
BABCOCK & WILCOX, 7% com.	118	117½	124½
Binghamton L., H. & P., $6 pf.	105	102	105½
Birmingham Elec., pf.—$7—no par	109	109½	111
Blackstone Valley G. & E., 6% pf.	b106	106	112
Blackstone Valley Gas & Elec., 10% com.—50	166½	132	169½
Blaw-Knox, com.†	d104½	91	105
Brazilian Trac., Lt. & Pwr., $7 com.	f208½	....	....
Brazilian Trac., Lt. & Pwr., com., new	f 53½	....	....
Broad River Pwr., 7% pf.	106	105	107½
Brooklyn Edison, 8% com.	227½	206½	235½
Buffalo, Niagara & East. Pwr., $1.60 pf.—25	f 26½	....	....
Buffalo, Niagara & East. Pwr. com. $1.20—no par	f 37	....	....
CALIFORNIA ELEC. GENERATING, 6% pf.	b 98	98	101
California Ry. & Pwr., 7% pf.	b135	....	....
Carolina Pwr. & Lt., pf.—$7—no par	h110	109	110½
Central & S. W. Util., $7 pf.—no par	a102½	99½	105½
Central & S. W. Util., pr. ln. $7 pf.—no par	a105½	103½	108
Central Ark. Ry. & Lt., 7% pf.	104	105	107
Central Ill. Pub. Serv., $6 pf.	a100	97½	100
Central Ind. Pwr., 7% pf.	a 99½	95	99½
Central Maine Power, 6% pf.	96	96	98
Central Maine Power, 7%	b108	109	112
Central Pwr. & Lt., 7% pf.	105½	104½	105½
Central States Elec., 7% pf.	113½	104½	113½
Century Elec., 6% com.	b143½	140	145
Cincinnati Gas & Elec., 5% com.	p 98	97½	99½
Cities Service, $6 pf.—no par	f 99½	87	94½
Cities Service, pf. B—no par	f 9½	8	8½
Cities Service, pf. BB—no par	f 94	80½	86
Cities Service, com.—20	f 59½	40½	58½
Cities Service, Bks. Shrs.—10	f 29½	22½	27
Cities Service Pwr. & Lt., 7% pf.	b106½	106	109½
Cities Service Pwr. & Lt., 6% pf.	b 98	95	100
Cleveland Elec. Illg., 6% pf.	112	113	115½
Cleveland Elec. Illg., 10% com.	390	350	410
Columbia Gas & Elec., 6% pf.	b108½	107½	110½
Columbia G. & E. com. $5—no par	94½	89½	97½
Columbus Elec. & Pwr., $2 com.—no par	71½	64	71½
Columbus Elec. & Pwr., 7%	113½	....	....
Columbus Ry., Pwr. & Lt., 7%	108	....	....
Columbus Ry., Pwr. & Lt., 7 % pf. B	107	....	....
Columbus Ry., P. & Lt. com.—no par	b115	....	....
Commonwealth Edison, 8% com.	a181	165	189
Commonwealth Pwr., 6% pf.	103½	102½	104½
Commonw'th Pwr., $2, com.—no par	72½	62½	72½
Conn. Lt. & Pwr., 8% pf.	120	120	123
Conn. Lt. & Pwr. 7% pf.	116	118	121
Cons. Gas of N. Y., pf.	102½	101½	102½
Cons. Gas of N. Y., com. $5—no par	140½	119½	141½
Cons. Gas, Elec. Lt. & Pwr. of Balti., 6% pf.	e111½	110½	113
Cons. Gas, Elec. Lt. & Pwr. of Balti., 6½% pf.	m111½	110½	113
Cons. Gas, Elec. Lt. & Pwr. of Balti., 7% pf.	m111	110½	115
Cons. Gas, Elec. Lt. & Pwr. of Balti., 5% pf.	e102	100½	102
Cons. Gas, Elec. Lt. & Pwr. of Balti., com. $3.00—no par	e 73	67½	72½
Consolidated Pwr. & Lt., 7% pf.	103½	....	....
Consumers Pwr., 6% pf.	103½	105½	106½
Consumers Pwr., 6.6% pf.	105	106	107
Continental Gas & Elec., 7% pr. pf.	106	106½	108½
Conti. G. & E. com. $4.40—no par	b230	240	265
Crocker Wheeler, com.†	30	24	30
Crocker Wheeler, 7% pf.	90	77	90
DALLAS PWR. & LT., 7% pf.	110½	110	111½
Dayton Pwr. & Lt., 6% pf.	108	108½	109½
Derby Gas & Elec., 7% pf.	99	96	99½
Detroit Edison, 8% com—ex. div.	183	166½	194½
Dubilier Condenser, com.—no par	2½	2½	3½
Duke Pwr., cap.	b140	130	145
Duquesne Lt., 7% pf.	m116½	115½	116½
EASTERN NEW YORK UTIL., $7 pf.	b110½	111	112½
Eastern New York Util. com.	m 65	....	....
Eastern States Pwr. $7, com.	12½	11½	15½
Eastern States Pwr., pf.	97	98	99
East. Tex. Elec., 7% pf.	107	106	109
Edison Elec. of Boston, $12 com.	d272	252	275
El Paso Elec. 7% pf.	113	110	112½
Elec. Bond & Share, 6% pf.	b109½	109½	111½
Elec. Bd. & Sh. Sec., com. $1—no par	f 92½	76	94½
Electric Household Util.†	a 21½	13½	24
Elec. Investors, 6% pf.—no par	102½	101	103½
Elec. Investors, com.†—no par	48	40½	48
Elec. Pwr. & Lt., ctfs. pf.	b107½	106½	110½
Elec. Pwr. & Lt., ctfs., 40% pd.	b125½	120½	125½
Elec. Pwr. & Lt., ctfs., com.—no par	39½	28½	39½
Elec. Refrig. cap.†	17	11½	17½
Elec. Ry. Securities, com.—no par	6½	....	....
Elec. St. Battery com. $5.25—no par	73½	69	77½
Elmira Wtr., Lt. & R.R., 7% pf.	b106½	104	107
Empire Pwr., ptc.†	31½	27½	35½
Engr. Pub. Serv. $7. pf.—no par	109½	107	110
Engr. Pub. Serv., com.—no par	40½	33	41½
Eureka Vacuum Cleaner, com. $4—no par	74½	69	79
FAIRBANKS MORSE, 7% pf.	b108	104	108½
F.-M., com.—$3—no par	37	32½	40½
Federal Lt. & Trac., com $1.40	51½	42	55
Federal Lt. & Trac., $6 pf.—no par	103	98	105
Florida Pwr. & Lt., 7% pf.	105	104½	107½
Ft. Worth Pwr. & Lt., 7% pf.	b114½	113	114½
GALVESTON-HOUSTON ELEC. 6% pf.	78	75	78
Galveston-Houston Elec., com.	32½	31	34
General Cable, Cl. A	80½	56	84½
Gen. Elec. $3 com.—no par	142	124	144½
Gen. Elec., special—6%	11½	11½	11½
Gen. Gas & Elec. (Del.) com A $1.50—no par	42½	35½	43½
Gen. G. & E. (Del.) pf. A $8—no par	b124	122½	126½
Gen. G. & E. (Del.) pf. A $7—no par.	b112	108½	113½
Gen. G. & E. (Del.) pf. B $7	b106	105½	108
Gen. Pub. Serv., $7 cum. pf., no par.	b117	110	120
Gen. Pub. Serv., com., no par	21	16½	21
General Public Utilities, $7 pf.	98½	98	99
Ga. Lt., Pwr. & Rys., com.	b 58	55	65
Ga. Ry. & Pwr., 8% pf.	m125	....	....
Ga. Ry. & Pwr., 7% pf.	m113½	....	....
Gt. Western Pwr., 7% pf.	b104½	....	....
IDAHO PWR., 7% pf.	104½	109	110½
Ill. No. Utilities, 6% pf.	b 96	96	98
Ill. Pwr. & Lt., 7% pf.	104½	103	107
Indianapolis Pwr. & Lt., 6½% pf.	104½	102	107½
IndianapolisPwr. & Lt., $7 pf.	104	100	105
Ingersoll Rand com.	b 91	90	94
Int. Combus. Engr., com. $2—no par	52½	45½	55½
Int. Combustion Engr., 7% pf.	101½	103½	105½
Int. Util., Class A—$3.50—no par	b 46	45	51½
Int. Utilities, Class B—no par	8	6½	10½
Interstate Pwr., pf.—$7—no par	101	99	103
Interstate Pub. Serv., 7% pf.	104	103	106
Iowa Ry. & Lt., 7% pf.	b 99	102	103
JERSEY CENTRAL PWR. & LT. CO., 7% pf.	107½	105	107
Johns-Manville, com.†—no par	117½	111½	125
Johns-Manville, 7% pf.	m121½	119½	121½

Stock Exchange: eChicago; bSt. Louis; cPhiladelphia; dBoston; eBaltimore; f Montreal; gCincinnati; hSan Francisco; iPittsburgh; jWashington. bBid price Saturday, March 17. fBid price Wednesday, March 21. mLatest quotations available. †Dividend rate variable.

Stock Quotations of Electric Light and Power and Manufacturing Companies (Continued)

(Prices on New York stock market unless otherwise noted. Unless otherwise noted the par, stated, or preference value of stock is $100.)

Companies	Bid Price Tuesday March 20	Low 1928	High 1928
KANSAS CITY PWR. & LT. pf. $7	k114¼	115	116¼
Kansas Gas & Elec., 7% pf.	l110	107	109
Kentucky Hydro-Elec., 7% pf.	a104½	102	104½
Kentucky Sec., 6% pf.	92	94	98
Kentucky Sec., 5% com.	150	140	150
Kentucky Utilities, 6% pf.	k102	100	103
LACLEDE GAS LT., 10% com.	k200	200	260
Lehigh Pwr. Sec., com.—no par	26¼	19¼	27¼
Long Island Ltg., 7% pf.	111	110½	112½
Long Island Ltg., 6% pf.	106½	107	108½
Long Island Ltg., com.†—no par	k178	170	185
Los Angeles Gas & Elec., 6% pf.	h108	105½	109½
Louisville Gas & Elec., cl. A. $1.75	30½	28	30
MAN. ELEC. SUPPLY, cap. $5—no par	58½	50	61
Manilla Elec., com.†—no par	k 47	45½	50
Maytag Mfg.,com.50—no par,	31½	30	34½
Memphis P. & L., pf.—$7—no par	109	109	111
Metropolitan Ed., pf.—$6—no par	105½	103	107½
Metropolitan Ed., pf.—$7—no par	k108	109	111
Metropolitan Ed., com. $5—no par	k140	125	155
Middle West Utilities, 7% pf.	a122½	116½	124½
Middle West Util., 7% pr. lien	a126½	125	129½
Middle West Util., com. $7—no par	a134	123½	135
Midland Utilities, pr. ln. 6% pf.	a 96½	94½	97
Midland Utilities, 6% pf. A	a 92½	90½	92½
Milwaukee Elec. Ry. & Lt., 7% pf.	k103	100	103
Milwaukee Elec. Ry. & Lt., 6% pf.	k100	98	101½
Minn. Pwr. & Lt., 7% pf.	l108	107	109
Miss. River Pwr., 6% pf.	108	94	109½
Miss. River Pwr., 3% com.	m 62	....	....
Mohawk Hudson Pwr., 1st pf.—$7—no par	k107	100	110
Mohawk Hudson Pwr., 2d pf.—$7—no par	k104	100	109
Mohawk Hudson Pwr., com.—no par	30½	29½	31½
Montana Pwr., 5% com.	163½	102½	167½
Montreal Pwr., 7½% com.	f 93	....	....
Mountain States Pwr., 7% pf.	k104	97	105
Mountain States Pwr., com.†	17	....	....
NASSAU & SUFFOLK LTG., 7% pf.	109	98	110½
National Carbon, 8% pf.	m138½	138	139
National Elec. Pwr., A†	a 31½	27½	32½
National Lt., Ht. & Pwr., com.	k 24	20	30
National, Light, Ht. & Pwr., 5% pf.	k 72	70	80
National Pwr. & Lt., pf.—$7—no par	k109½	108½	111
National Pwr. & Lt., com.†—no par.	26½	21½	27½
National Pub. Serv., 7% pf.	102	99	103
National Pub. Serv., 7% ptc., pf.	114	....	....
National Pub. Serv., A com. $1.60—no par	25½	22	27½
National Pub. Serv., B com.—no par	k 27½	24½	30
Nebraska Pwr., 7% pf.	l111	110	111½
Nevada-Calif. Elec., com.	k 38½	33½	42
New Brunswick Pwr., 4% pf.	k 62	60	70
New Eng. Pub. Serv., pr. ln. pf. $7	k108	98½	109½
New Eng. Pub. Serv., pf. $7	k106	95	108
New Orleans Pub. Serv.—7% pf.	108	106	110
N. Y. & Queens Elec. Lt. & Pwr., 5% pf.	100	91	100
N. Y. Central Elec., 7% pf.	k103½	101	104
New York Power & Light 7%pf.	115	....	....
New York Power & Light, 8% pf.	m114	....	....
Newport News & Hampton Ry., Gas & Elec., 6% com.	m109	110	115
Newport News & Hampton Ry., Gas & Elec., 7% pf.	m109	110	115
Niagara Falls Pwr., 7% pf.—25.	28	27½	28½
No. Amer., 6% pf.—50.	54½	53½	55
No. Amer., com.—10	67	58½	67
No. Amer. Edison, $6 pf.—no par	103½	102½	105½
No. Caro. Pub. Serv., pf.—$7—no par	m109	93	105
Northeastern Pwr., com.	20½	19½	23
No. N. Y. Utilities, 7% pf.	107	103	109
No. Ohio Pwr., com.—no par.	25½	18	25½
No. Ont. Lt. & Pwr., 6% pf.	k 99	94	100
No. Ont. Lt. & Pwr., 4% com.	k 72	73	78
No. States Pwr. (Del.), 7% pf.	k109½	108½	109½
No. States Pwr. (Del.), 8% com.	136½	123	136½
No. Texas Elec., 6% pf.	55	45	70
No. Texas Elec., com.	19	....	....
OHIO BRASS, com. B $4—no par.	100	89	100½
Ohio Brass, 6% pf.	k107	106	111
Ohio Pwr., 6% pf.	106½	104	107½
Ohio Pub. Serv., $6 pf.	k102	95	102
Ohio Pub. Serv., 7% pf.	111	107	112
Ohio River Edison, 7% pf.	108	106	109½
Oklahoma Gas & Elec., 7% pf.	112½	106	114
PACIFIC Gas & ELEC., 6% pf.	27½	26½	28½
Pacific Gas & Elec., 8% new com.	48	43½	49½
Pacific Pwr. & Lt., 7% pf.	l109½	106	109
Penn Cent. Lt. & Pwr., $5 pf.—no par	c 80	79½	82
Penn-Ohio Edison, 6% pf. no par	k 94½	93½	96
Penn-Ohio Edison, 7% pf.	107	106½	109
Penn-Ohio Pwr. & Lt., 7% pf.	109½	99	110
Penn Pwr. & Lt.—$7—no par	l109½	109½	110½
Penn Wtr. & Pwr., $2.50 com., new	g 70	68	72½
Phila. Co., 5% pf.—50.	k 45½	45½	48½
Phila. Co., 6% pf.—50.	54	52	54½
Phila. Co., com.—50.	k156	149½	163
Phila. Elec., 8% com.—25.	c 59½	55½	59½
Portland Elec. Pwr., 7% pf.	102½	100	104½
Portland Elec. Pwr., 6% pf.	93½	78	96
Portland Elec. Pwr., 6% 2d pf.	86	55	88
Portland Elec. Pwr., com.	51½	42½	52
Potomac Elec. Power, 6% pf.	j111½	....	....
Pwr. Sec., pf.—no par	k 58	50	60
Pwr. Sec., com.—no par	k 12	5	15
Public Serv. of Colorado, 7% pf.	l105	....	....
Pub. Serv. of N. J., 6% pf.	105½	103½	106½
Pub. Serv. of N. J., 7% pf.	k118½	118	120½
Pub. Serv. of N. J., $2 com.—no par	46½	41½	46½
Pub. Serv. of No. Ill., 6% pf.	a111½	110	113½
Pub. Serv. of No. Ill., 7% pf.	a119	119	121
P. S. of No. Ill., com. $8—no par	a172	159½	180
Pub. Serv. of No. Ill., $8 com.	a172	159½	180
Pub. Serv. of Okla., 7% pr. ln.	k106	100	107
Pub. Serv. Elec. & Gas, 6% pf.	109	108	110½
Puget Sound Pwr. & Lt., 7% pf.	109½	109	113
Puget Sound Pwr. & Lt., $6 pf.—no par	99	92	99½
Puget Sound Pwr. & Lt., com.	60	34½	63½
RADIO CORP. OF AMER., $3.50 pf.—50.	56½	54½	57½
Radio Corp. of Amer., com.—no par.	160	85½	160
Rhode Island Public Service, pf. $2—no par	31½	30½	31½
Rochester Gas & Elec. 6% pf. D.	105	105½	106½
Rochester Gas & Elec., 7% pf. B.	107	105	107
Rochester Gas & Elec., 6% pf. C.	105½	105½	106½
SAN JOAQUIN Lt. & Pwr., 7% pr. pf.	k116	110	117½
St. Joseph Ry., L., H. & P., 5% pf.	k 75	70	75
Servel, Inc.	7	4½	7½
Sierra Pacific Elec., 2% com.	k 37	29	38½
Sioux City Gas & Elec., 7% pf.	107	100	108½
Southeastern Pwr. & Lt., pf.—$7 no par.	j 109	....	....
Southeastern Pwr. & Lt., ptc. pf.	j 87½	....	....
Southeastern Pwr. & Lt., com.—no par.	47½	40½	47½
So. Calif. Edison, 8% pf.	k 46½	38½	41
So. Calif. Edison, 7% pf.	k 29	27½	29½
So. Calif. Edison, 6% pf.	26½	25½	27½
So. Calif. Edison, 8% com.	48	43½	48
Southern Cities Utilities, 7% pf.	k 80	75	78
Southwestern Lt. & Pwr., A $3.	75	60	80
Southwestern Lt. & Pwr., B.	65	60	65
Southwestern Lt. & Pwr., $6 pf.	91½	88	92½
Southwestern Pwr. & Lt., 7% pf.	k111½	103	113
Standard Gas & Elec., 8% pf.	67½	65	68
Standard Gas & Elec., 7% pr. pf.	114	110½	114
Standard G. & E., com. $3.50	64½	57½	65
Standard Power & Light, com.	41½	29½	45
Standard Pwr. & Lt., 7% pf.	106½	103½	106½
Staten Island Edison, pf.—$6—no par	102	99	103½
Superheater, $6 com.—no par.	165	162	175
Syracuse Lighting, 7% pf.	k110	103	111
Syracuse Lighting, 8% pf.	k117½	114	119
TAMPA ELEC., com. $2	64	62	64½
Tenn. Elec. Pwr., 6% pf.	102	92	103
Tenn. Elec. Pwr., 7% pf.	108	107	110
Terre Haute, Ind. & East. Trac., 5% pf.	k 10	....	....
Terre Haute, Ind. & East. Trac., com.	k 1	1	3
Tex. Pwr. & Lt., 7% pf.	l114½	113½	115
Tide Water Pwr., 8% pf.	110	108	112
Timken Roller Bear., com.—$4 no par.	126½	112½	134
Toledo Edison, 7% pf.	l109½	....	....
Toledo Edison, 6% pf.	k104	95	105
Toledo Edison, 6% com.	k145	120	150
Tri-City Ry. & Lt., 6% pf.	k 99	96	102
UNITED GAS & ELEC., 7% pf.	97	98	103
United Gas & Elec. (N. J.), 5% pf.	75	70	77
United Gas Impr., 8% com.—50.	c120½	111½	120½
United Lt. & Pwr., pf.—$4—no par.	k 56	49	56½
United Lt. & Pwr., pf.—$6.50—no par.	a 98	95	100½
United L. & P., com. A .48—no par.	a 18½	14	19½
United L. & P., com. B .48—no par.	a 24	19	24
Utah Pwr. & Lt., 7% pf.	l 111½	109½	111½
Utica Gas & Elec., 7% pf.	105	105	106½
Utica Gas & Elec., 8% com.	k200	215	225
Utilities Pwr. & Lt., 7% pf.	101	98	103
Utilities Pwr. & Lt., com. A $2.	32½	28½	34½
Utilities Pwr. & Lt., com. B $1—no par.	24½	18½	26½
VERMONT HYDRO-ELEC., 7% pf.	k 98½	95	102
Virginia Elec. & Pwr., 7% pf.	k110½	108	111
WAGNER ELEC., 7% pf.	b101	96½	102
Wagner Elec., com.—no par.	b 53	37	55
Washington Ry. & Elec., 5% com.	j485	....	....
Washington Ry. & Elec., 7% pf.	j103½	....	....
Washington Wtr. Pwr., 8% com.	k227	175	235
West Penn Elec., 7% pf.	113½	109½	114½
West Penn Elec., Cl. A $7.	k107½	106½	110½
West Penn Pwr., 7% pf.	116	114½	116
West Penn Pwr., 6% pf.	k109½	109½	113
West Virginia Lt., Ht. & Pwr., 7% pf.	k 95	94	100
Western Pwr., 7% pf.	k102	98	105
Western States Gas & Elec., 7% pf.	100	100	106
Western States Gas & Elec., com.	38	....	....
Westinghouse Elec. & Mfg., 8% com.—50.	105	88½	105½
Weston Elec. Instrument, Cl. A $2—no par, ex. div.	32½	▼30½	34
Weston Elec. Instrument, com.—no par.	12½	12½	14½
Wheeling Elec., 6% pf.	k104	95	104
Worthington Pump, 7% pf. A.	50	46½	55
Worthington Pump, 6% B.	46½	41	49½
Worthington Pump, com.	31½	28	34½
YALE & TOWNE com. $5—25.	k 70	70	75

Stock Exchange: *a*Chicago; *b*St. Louis; *c*Philadelphia; *d*Boston; *e*Baltimore; *f*Montreal; *g*Cincinnati; *h*San Francisco; *i*Pittsburgh; *j*Washington. *k*Bid price Saturday, March 17. *l*Bid price Wednesday, March 21. *m*Latest quotations available. †Dividend rate variable.

Illinois Power & Light to Retire Preferred Stock

It is proposed by the Illinois Power & Light Corporation, Chicago, Ill., to call and retire all of its 7 per cent cumulative preferred stock. In order to raise funds with which to accomplish this, the corporation proposed to create and sell a new class of preferred stock. This class will be without par value, will be preferred in involuntary liquidation at $100 per share and in voluntary liquidation at $110 per share, plus accrued dividends. The call price will also be $110 per share. The call price of the existing 6 per cent preferred stock, as well as its price on voluntary liquidation, will be $110. Otherwise, the new class will have substantially the same charter protection as the existing preferred stock.

This proposed refinancing plan is subject to action of the stockholders at a meeting to be held for that purpose on April 23 and to the approval of the Illinois Commerce Commission.

RECENT LISTINGS.—The New York Stock Exchange has authorized the listing of 1,136,344 shares of second preferred stock, series A, of American & Foreign Power Company outstanding and 633,155 shares of second preferred, series A, to be added to the list on official notice of issuance, making the total amount of second preferred stock, series A, applied for 1,769,499 shares. There have also been recently authorized for listing 250,000 additional shares (no par value) preferred stock of the North American Edison Company on official notice of issuance upon conversion of its 5 per cent debentures, series A, due March 1, 1957, making a total of 450,000 shares of preferred stock applied for. Additional common stock of the Pacific Gas & Electric Company has been authorized for listing on the New York Stock Exchange to the amount of $6,458,350, making the total amount applied for $71,191,150. The listing of $60,000,000 in 5 per cent secured gold bonds, series A, of the Philadelphia Company has been authorized for listing on the New York Stock Exchange, as has also $45,000,000 in first and refunding mortgage gold bonds, 4½ per cent series, of the Public Service Electric & Gas Company.

SHAWINIGAN WATER & POWER INCREASES STOCK.—At a special meeting of the shareholders of the Shawinigan

Water & Power Company held Feb. 21, the capital stock was increased from 1,200,000 shares without par value to 1,600,000 share without par value and at a subsequent meeting of the directors an issue of stock, without par value, to the shareholders was authorized at a price of $50 per share on the basis of one share of new stock for each four shares of the outstanding holdings of record March 26. Rights expire May 1.

New Capital Issues

First lien 5½ per cent gold bonds, series B, of the United Public Utilities Company were offered to the amount of $3,750,000, at 97¾ and interest, yielding about 5.70 per cent. These bonds will mature April 1, 1947. The United Public Utilities Company, a New Jersey corporation, controls subsidiaries operating in a group of communities in Ohio, Indiana, North Dakota, South Dakota, Alabama and Louisiana.

The American Commonwealths Power Corporation issued 50,000 shares of first preferred stock, $6.50 dividend series, at 95 and accrued dividend, yielding about 6.85 per cent. Proceeds from the sale of the stock will be used for the acquisition of stock of certain companies and for other corporate purposes.

NEW YORK UTILITY CHANGES NAME.—The New York State Gas & Electric Corporation, Ithaca, N. Y., has filed a certificate in the office of the Secretary of State changing its corporate name to New York State Electric Corporation.

Annual Reports Show Gross Up 8.9 Per Cent

APPROACHING the normal yearly growth, gross revenue of power and light companies increased considerably less in 1927 than was the case during 1926. To date approximately 50 per cent of the companies, or, more properly, companies representing half the gross revenue of the industry, have issued their 1927 financial statements. The aggregate revenues of these companies has increased but 8.9 per cent over that reported by them in 1926, while 1926 figures show a 13.6 per cent growth over 1925 for the same companies.

These figures indicate that estimates published by ELECTRICAL WORLD in the issue of Jan. 7 were substantially correct, in so far as this half of the industry is concerned. At that time it was estimated that gross revenue for the entire year would exceed that of 1926 by 8 per cent, reaching a total of $1,783,700,000. Companies which have already reported have a gross of $850,400,000, against $780,347,000 in 1926.

While substantially lower than the 1926 increase, and also that of 1925, an annual increase of 8 to 9 per cent approximates what would appear to be a normal or average annual increase. In 1926 the revenue of the industry increased 11.6 per cent; in 1925, 9.3 per cent, and in 1924, 7 per cent. Furthermore, the increase in power generated in 1927 over 1926 was 8.6 per cent.

Metropolitan Edison Simplifies Structure

Fifteen issues of securities, totaling over $20,000,000, will be retired as part of a plan for simplification of the capital structure of the Metropolitan Edison Company. To accomplish the plan, as well as to pay for additions and betterments to the company's property, and other corporate purposes, an issue of $25,000,000 Metropolitan Edison Company first and refunding mortgage 4½ per cent bonds will soon be offered the investing public. The plan will also effect a substantial saving in interest charges. Carrying out of the program will reduce the number of issues of the company from seventeen to three. The funded debt, upon completion of the financing, will consist of the new issue of bonds, $7,650,000 first and refunding mortgage 5 per cent bonds (secured by the same mortgage as the new 4½s) and one divisional issue which is non-callable—$1,500,000 York Haven Water & Power Company 5 per cent bonds, due June 1, 1951. The issues being retired range in amounts from $6,252,600 down to $10,500. They consist of one Metropolitan Edison Company issue and fourteen issues of divisional bonds. The principal issues being retired are: $6,080,000 Metropolitan Edison Company 6 per cent bonds, $6,252,600 Pennsylvania Edison Company 5 per cent bonds, $3,250,000 Metropolitan Power Company 6 per cent bonds, $2,348,000 Metropolitan Electric Company 5 per cent bonds, $1,345,000 York Haven Water & Power Company 5 per cent bonds.

Hartford Electric Light Company Reports Good Year

CONTINUED prosperity shared with its customers is reported in the annual message of President Samuel Ferguson of the Hartford (Conn.) Electric Light Company to stockholders covering the year 1927. The various rate reductions made at the beginning of the year caused a decrease in revenue in excess of $300,000, compared with what it would have been at last year's prices, but in the face of this gross revenues increased approximately $275,000 over 1926. Steady gains marked the year's business. Net earnings applicable to dividends and surplus enabled the company to declare a 40 per cent "customers' dividend" in the form of a discount on all October bills, which amounted to $185,000. Energy sold locally totaled 145,000,000 kw.-hr., against 137,000,000 kw.-hr. in 1926, while power sold other companies totaled 52,000,000 kw.-hr., against 55,000,000 kw.-hr. the year previous. The total power exchanged (with the Connecticut Valley group) was 23,000,000 kw.-hr., compared with 31,000,000 the year before. Sales of electrical energy totaled $5,330,400 (after customers' dividend reduction); expenses totaled $2,655,200, and net after taxes and retirement reserve was $1,711,900, compared with $1,662,900 for 1926. Total income for 1927 was $2,058,400, against $1,842,400 for 1926, and the balance carried to surplus was $336,400, against $384,100 for 1926. During the past three years "customers' dividends" have totaled $694,000.

President Ferguson states that during the year the company's investment in 10,000 shares of the New England Power Association was sold to the International Paper Company, the profits from the transaction being distributed to stockholders in the form of a payment of $1 per share. Regarding the deposit of stock, Mr. Ferguson states that all the directors and more than 35 per cent of the stockholders have complied with the company's recommendation that this be done, and suggests that others holding less than 200 shares should deposit all their stock and those holding larger amounts should deposit 200 shares to indicate their approval of the trust project, voting the balance themselves. The year was also a successful one for the Connecticut Power Company, which is largely owned by the Hartford company. The net earnings of the former increased $183,000, which is approximately 20 per cent greater than the earnings figure for the previous year.

Energy Output in Mexico

Statistics on the output for the year 1926 of the leading electrical operating companies in Mexico, according to information recently received from the Mexican Department of Industry, Commerce and Labor, are given in the following table:

Company	Kilowatt-Hours Generated
Cia. Mexicana de Luz y Fuerza Motriz, S. A.	593,472,460
Cia. Agricola y de Fuerza Eléctrica del Rio Conchas, S. A.	137,149,400
Cia. de Tranvias Luz y Fuerza de Puebla	86,400,440
Cia. Eléctrica de Chapala	80,175,522
Michoacán Power Co.	53,715,788
Cia. Eléctrica de Tampico, S. A.	38,789,590
Guanajuato Power & Electric Co.	36,617,916
Cia. Tranvias Luz y Fuerza Monterrey	26,085,980

Business News and Market Conditions

Bureau of Commerce Plans to Expand Facilities

Among the developments of the Bureau of Foreign and Domestic Commerce of the Department of Commerce made possible by added appropriations for the next fiscal year will be the establishment of six new district offices. These branches are to be located in Denver, Indianapolis, Birmingham, Pittsburgh, Milwaukee and one in the state of North Carolina. The Commerce Department already maintains 23 district offices and 34 co-operative offices in this country. The object of these offices is to render immediate service to nearby business men. The records of the department show that during the last fiscal year these offices performed more than 2,000,000 commercial services, an increase of approximately 600 per cent during the past five years During the same period statements from 405 concerns thus served indicate actual sales and savings approximating $10,000,000. These branch offices are equipped with foreign trade information regarding conditions abroad, sales openings, names of prospective buyers, packing suggestions, foreign tariffs, etc. They also have, or are developing, facilities for the promotion of domestic trade.

Another advance in the program of the Bureau of Foreign and Domestic Commerce during the next fiscal year will be preliminary work on three new regional surveys in the national commercial survey program which is planned ultimately to cover the entire United States. The "Commercial Survey of the Southeast" has already been completed and is available at the price of $1 per copy from the Superintendent of Documents, Government Printing Office, Washington, D C., or from any district office of the department. Field work in the New England survey has been completed and the report is now being prepared. Field work on the Pacific Southwest is well under way. Preliminary steps also have been taken for beginning field work in connection with four other regions.

Primary Market for Carbon Brushes

An estimate of the primary market for carbon brushes, based on the 1925 census of manufactures compiled by the Department of Commerce, is given in the accompanying table. It is further estimated that the replacement market would be four times the primary market, considering the average life of the equipment listed as ten years and the average life of the carbon brush 2½ years.

British Act on Wire and Cable Imports

A report of the standing committee of the Board of Trade to Parliament respecting the importation of insulated electric wires and cables has been published and is now available through the British Library of Information, 5 East 45th Street, New York, at 10 cents per copy. Primarily the report recommends that all imported wires and cables be properly identified as to their origin at the time of importation and also at the time of sale except such material as forms an integral part of a completed article.

Delinquent Electrical Accounts

(Data Supplied by National Electrical Credit Association)

NUMBER OF ACCOUNTS REPORTED

Division	January 1927	January 1928	Per Cent Increase or Decrease	Twelve Months 1926–7	Twelve Months 1927–8	Per Cent Increase or Decrease
New York	372	260	−30.1	4,238	3,508	−17.2
Middle and Southern Atlantic States	137	159	+16	2,172	2,021	− 6.95
New England	112	133	−18.7	1,508	1,884	+24.9
Pacific Coast	9	11	+22.2	249	222	−10.8
Central	767	798	+ 4.04	10,126	10,515	+ 3.84
Total	1,397	1,361	− 2.58	18,293	18,150	− .78

TOTAL AMOUNTS REPORTED

Division	January 1927	January 1928	Per Cent Increase or Decrease	Twelve Months 1926–7	Twelve Months 1927–8	Per Cent Increase or Decrease
New York	$62,293	$49,527	−20.4	$639,987	$552,454	−13.6
Middle and Southern Atlantic States	14,289	17,511	+22.5	269,412	239,255	−11.2
New England	10,608	14,774	+39.2	108,887	225,462	+107
Pacific Coast	1,154	1,933	+67.5	34,623	27,311	−21.1
Central	91,704	100,755	+ 9.87	1,223,498	1,286,981	+ 5.19
Total	$180,048	$184,500	+2.47	$2,278,407	$2,331,463	+2.42

AVERAGE AMOUNTS

Division	January 1927	January 1928	Twelve Months 1926–7	Twelve Months 1927–8
New York	$167	$190	$1,807	$1,901
Middle and Southern Atlantic States	104	110	1,446	1,432
New England	94	111	1,090	1,444
Pacific Coast	128	175	1,583	1,763
Central	120	126	1,433	1,362

Estimate of Primary Market for Carbon Brushes

Based on the 1925 Census of Manufactures Compiled by the Department of Commerce

Type of Equipment	Number Produced, 1925	Average Number of Brushes per Machine	Total Number of Brushes
Alternating-current generators:			
Steam-turbine driven	386	4	1,544
Other including synchronous condensers	1,712	2	3,424
Direct-current generators:			
Steam-turbine driven	6,562	8	52,496
Other	9,410	4	37,640
Motor-generator sets and dynamotors:			
Under 50 kw	13,530	3	40,590
		8	108,240
50-kw. and over	779	6	4,674
		60	46,740
Automotive generator and starter motors	3,879,208	3	11,637,624
Self-contained power and lighting outfits	43,408	4	173,632
Motors:			
Fractional horsepower	2,288,348	2	4,576,696
1 hp. and over, direct current	77,637	8	621,096
Polyphase induction motors:			
200 hp. and under	25,000	6	150,000
	With brushes		15,000
Over 200 hp	1,000	15	
	With brushes		
Single phase	75,688	2	151,376
Synchronous motors	1,985	4	7,940
Electric fan motors	300,000	2	600,000
	With brushes		
Radio transmitting sets	1,076	4	4,304
Vacuum cleaners	1,107,592	2	2,215,184
Portable electric tools:			
Grinders and buffer	10,000	2	20,000
Drills	70,000	2	140,000
Carbon contacts	.....	..	500,000
Total			21,108,200

Market Conditions

SALES during March have shown a decidedly better trend than in the previous two months. Buying of small motors is prominent in the New England district. Several large orders for general schedule material also are reported. Much interest is noted in street lighting, and there is a steady demand for construction material. Industrial sales are active in the Eastern district and include turbo-generator units totaling $100,000. Substation equipment also was in demand by central-station companies.

Industrial buying continues active in the Southeast and steady business was reported. A street-lighting contract involving more than $1,000,000 was placed in St. Louis, and a normal volume of motor and transformer business was done with industrial concerns. The Middle West reports a general improvement in March with the trend continuing. On the Pacific Coast power company buying of equipment was the outstanding business, which included a 32,200-hp. waterwheel generating unit.

Metal Markets Quiet—Little Change in Prices

Buying of the non-ferrous metals has been in limited volume in the domestic market. This lull was not unexpected after the activity of the first half of March. The large primary producers of copper continued to maintain their position at 14⅛ cents. Most of the business was done at lower prices ranging down to 14 cents, Connecticut. In spite of absence of active buying, lead prices continue firm at 6 cents, New York. Zinc is quotably a little stronger than a week ago, but sales are decidedly sparse.

NEW YORK METAL MARKET PRICES

	Mar. 14, 1928 Cents per Pound	Mar. 21, 1928 Cents per Pound
Copper, electrolytic	13.825	13.78⅛
Lead, Am. S. & R. price	6	6
Antimony	10⅛	10⅛
Nickel, ingot	35	35
Zinc spots	6	6.0⅛
Tin, Straits	50⅛	53⅛
Aluminum, 99 per cent	24.30	24.30

Base copper price March 21, 1928, 15⅛ cents.

Industrial Sales Active in Eastern District

Industrial and utility business combine to bring increased activity in the Eastern market. Industrial interests have been developing a pronounced demand for prime movers of the turbo-generator type. A leading manufacturer of such equipment has secured an order from a company at Waterbury, Conn., for a 2,500-kw. unit to cost about $45,000, and a paper mill at Albany, N. Y., has purchased a similar unit to cost approximately $42,000. A chemical concern at Syracuse, N. Y., has contracted for several smaller turbo-generators for its local plant, totaling around $20,000. While the call for industrial motors has slackened, a resumption of demand is looked for at an early date. Copper mining companies have been prominent in the market recently for motors and kindred industrial apparatus and some sizable commitments are expected from this quarter in a short time, Baking interests, likewise, have been active, and among others the Continental Baking Company, New York, will likely be a large purchaser at an early date in connection with proposed plant expansion. Export account for industrial motors, particularly from South American mining companies, is showing improvement, with a primary call for units of heavier and larger sizes. Business in fractional-horsepower motors is fair, with a tendency to be a little spotty.

Substation and affiliated electrical equipment continues in good demand for central-station account. A utility company in the metropolitan district has placed an order for oil circuit breakers to an amount of about $175,000, while another central-station company has contracted for 2,000 distributing switches of the 7,500-volt type, totaling $14,000. A Buffalo utility company has purchased 200 switches of the 13,000-volt open type for rural line service from the same manufacturer. Circuit-breaker business has shown advancing proportions during the past month and there are excellent prospects for further sizable commitments. Line hardware has been recording some good sales and cable reels have been in demand by telephone companies. Marine electrical equipment is expected to enjoy a pronounced call within the next month or two; the government has several contemplated projects which are to be definitely settled within that time, while the city of New York will probably place orders for an electric-operated ferry-boat and fire-boat.

A feature of immediate construction work in the Eastern district is the expansion program of the Public Service Electric & Gas Company, Newark, N. J. Other construction projects include the following: The International Nickel Company, New York, will improve its properties at Port Colborne and Copper Cliff, Ontario, over a period of months to cost $12,000,000. The DuPont Cellophane Company, Buffalo, N. Y., plans an addition to its paper mill to cost about $200,000. Riverside, N. J., will improve its street-lighting system. The Amalgamated Silk Company, East Mauch Chunk, Pa., has authorized the electrification of its mill. The Pennsylvania Power & Light Company, Allentown, Pa., will build transmission lines in Roaring Creek at Catawissa Townships through two subsidiaries. The Stetson Rubber Company, Butler, Pa., will build a mill to cost $100,000. The Eastern Shore Public Service Company plans a transmission line to Millville, Ocean View, Bethany Beach and vicinity. The Love Point Light & Power Company, Love Point, Md., will build a transmission line to Queenstown. The Kelly-Springfield Tire Company, Cumberland, Md., plans a refrigerating plant for rubber conditioning to cost $100,000. The Board of District Commissioners, Washington, D. C., will receive bids until March 26 for lamp-posts and fittings for the electrical department. The Bureau of Supplies and Accounts, Washington, D. C., will receive bids until April 3 for insulated cable and wire for Eastern and Western yards (Schedule 8708).

Small Motor Buying Steadies New England Trade

With the demand for heavy equipment and central-station supplies rather quiet, the encouraging activity in small motors in the New England district gives notable strength to the market. The sales volume of motors was slightly above normal and among the orders were recorded many units from 15 hp. to 600 hp. Small switch and control sales are fair. A number of large orders for general schedule material were placed, one for $6,500, another for $2,500, and consignments for general contractors' supplies totaling over $15,000. Much interest is reported in street lighting. Electric automatic pumping units are being considered for two localities in southeastern Massachusetts. Inquiries also are being received for a large number of special institutional lighting systems. Much encouragement is seen in the steady demand for new construction requirements.

Construction projects are as follows: The Boston Ice Company has bids open for a plant for Cambridge. The U. S. Gypsum Company has acquired a water frontage and will expend about $1,500,000 for a new plant at Boston. The Edison Illuminating Company, Boston, plans additions to the Edgar station consisting of extensions to the switch house and boiler plant. The Boston Rubber Shoe Company, Malden, Mass., has authorized electrification of its mills at Malden and Melrose, Mass.

Steady Business Reported in the Southeast

An order for a complete 25,000-kva. substation was the most prominent one placed in the Southeast. The volume of business in meters and transformers is good, though the individual orders average about $1,500. One company purchased $5,700 worth of small power and distribution transformers and $1,200 worth of house type meters. A central-station company in south Georgia ordered regulators amounting to $4,000, while another company purchased $1,300 worth of sign equipment for four small installations. In connection with merchandising activities in the section, one power company recently sold 2,650 flat-irons in one town in a special campaign.

One of the small independent telephone companies in Georgia ordered 250 Southern white cedar poles.

A textile mill in North Carolina purchased a 1,000-kw. steam turbine and auxiliary equipment for its bleachery and a textile plant in Alabama ordered motors, transformers and switchboard equipment amounting to $17,000. A textile resale firm placed an order for motors totaling $8,000, and a Georgia ice plant ordered synchronous motors amounting to $2,000. Wiring materials totaling $30,000 are being ordered in connection with the Southern Railway shops at Macon, Ga., though this amount is being split in a number of small orders to local jobbers. Motor and transformer equipment on that job will cost in the neighborhood of $50,000 and orders on the same are pending. A municipally owned plant in one of the larger Florida towns is contemplating the purchase of a 1,500-kw. turbo-generator and a number of active negotiations for waterwheels and generators for the northern part of the section are under way. It is expected these latter propositions will be definitely closed during the coming week.

Construction projects are as follows: The Georgia Portland Cement Corporation, Saundersville, Ga., plans a mill to cost $1,000,000. Henderson, Ky., plans improvements in its power plant to cost $50,000. Paducah, Ky., has authorized surveys for a municipal power plant. The Carolina Gas & Electric Company will build a transmission line to Kinston, N. C. The North Carolina Public Service Company plans a transmission line to Mebane, N. C., and vicinity. The Powell Knitting Company, Spartanburg, S. C., plans a mill addition to cost $175,000. Danville, Va., plans improvements at its municipal power plant to cost $35,000.

Large Street Light Contract Placed in St. Louis

Conditions in the St. Louis district have been fair. A normal volume of medium-sized motors and transformers for industrial concerns has been purchased. Contracts for street lighting to include the St. Louis down-town section were awarded at a total cost of considerably over $1,000,000. A railroad company signed a contract for five gas-electric cars, each with a 400-hp. single-unit power plant at a total cost for electrical equipment of about $70,000. Another railroad company also bought apparatus for converting four gasoline cars to gas-electric service at a total cost of $30,000.

Construction projects are as follows: The Southwestern Gas & Electric Company, Shreveport, La., plans a steam power plant to cost $1,000,000. Normandy, Mo., plans a vocational school to cost $125,000. The Commissioner of Indian Affairs, U. S. Indian Service, St. Louis, Mo., will receive bids until April 9 for electrical supplies (Schedule 22-a). The Bartholomew Battery & Supply Company, St. Louis, Mo., plans a new plant at Columbia, Mo., to cost $100,000. The Pillsbury Flour Mills Company, Minneapolis, Minn., plans a mill and elevator at Enid, Okla., to cost $1,000,000. The Southwestern Irrigated Cotton Growers' Association, El Paso, Tex., plans a cottonseed oil mill to cost $150,000. The Panhandle Power & Light Company plans construction of a transmission line to Claude, Tex. The Gates Chemical Company, Denver, Colo., plans a branch plant at Houston, Tex., to cost $200,000. The Fair Baking Company, San Antonio, Tex., will build a baking plant at Houston, Tex., to cost $175,000. Poplar Bluff, Mo., and Port Arthur and Forth Worth, Tex., plan ornamental lighting systems.

Improvement Noted in Middle West

The consensus of opinion in the Middle West is that the first half of March showed an improvement and the last half will show the same trend. Reports emanating from the steel industry are encouraging and considerable construction work is under way. Utility companies are preparing for spring activities with a large amount of line extension planned. Orders placed covered eighteen 15,000-amp., two 2,000-amp. and four 4,000-amp., 15-kv. oil circuit breakers and disconnecting switches valued at $10,000, and "Mazda" lamps valued at $150,000. Jobbers' sales have accelerated somewhat.

Construction projects are as follows: The Miehle Printing Press & Manufacturing Company, Chicago, plans additions in plant to cost $500,000. The Buick Motor Car Company, Flint, Mich., plans a factory branch in Chicago, to cost $600,000. The Iowa Soap Company, Burlington, Iowa, will build a plant to cost $100,000. The Interstate Power Company, Dubuque, Iowa, plans a power plant at Harper's Ferry, Iowa. Hawarden, Iowa, has approved a municipal power plant to cost $40,000. The Iowa Railway & Light Company has applied for permission to build a hydro-electric plant on Cedar River, near Rochester, Iowa, to cost $2,000,000. The Consumers Power Company, Jackson, Mich., plans a hydro-electric plant in vicinity of Morley, Mich., to cost $5,000,000. Mora, Minn., contemplates a municipal power plant. Harvard, Neb., has authorized $40,000 for a municipal power plant. The Nebraska Electric Power Company plans an addition to its power plant at Ogallala, Neb. Cincinnati, Ohio, is having plans drawn for an automotive trade school, to cost $125,000. The Marshall Electric Company, Marshalltown, Iowa, plans a transmission line for service at Hartland, Dillon and Marietta. The Indiana General Service Company will build a transmission line from Fort Wayne to Marion, Muncie and Kokomo to operate at 132,000 volts. The Otter Tail Power Company plans reconstruction of transmission lines at Lisbon, Forman, Enderlin and Cogswell, N. D. Cedar Rapids, Iowa, and Whitefish Bay (Milwaukee, P. O.), Wis., will build ornamental lighting systems.

Power Companies Buy Equipment on Pacific Coast

Power company business has bulked large on the Pacific Coast. The outstanding order was placed by Los Angeles City for its San Francisquito plant No. 1 and awarded to the Allis-Chalmers Manufacturing Company for a 32,200-hp. waterwheel, valued at $117,465, and a 25,000-kva. generator, valued at $165,200. The Westinghouse Electric & Manufacturing Company also was awarded a contract for oil circuit breakers to cost $29,294. Los Angeles also is in the market for 700,000 ft. of guy strand and $20,000 worth of poles. Eugene, Ore., is buying the initial material for its 18,000-hp. plant, to cost eventually $2,250,000, and is placing orders for a 9,000-hp. turbo-generator at a cost of $73,000, and six 2,500-kva. transformers for $34,660. Material for a 15-mile farmers' telephone line is wanted in the Ukiah district and for a 25-kilometer line by Mazatlan, Mexico. Railroad buying is rather quiet, industrial business is good and contractors' business, after a very poor February, is decidedly better.

Numerous motor orders placed by irrigation and orchard districts in eastern Washington and by lumber mills in the Puget Sound district, for replacements mainly, amounted to approximately $40,000 and included about 250 motors comprising from 300 hp. down for a "Kraft" paper mill in Pierce County. Tacoma also placed an order for its annual requirements of power and distribution transformers approximating $100,000. Specifications have been issued for motors and pumps for a cold storage plant in Wenatchee to cost $150,000. The British Columbia Electric Railway Company plans immediate construction of a 20,000-kw. distributing station in Victoria. The Pacific Telephone & Telegraph Company plans additional long-distance circuits connecting Seattle, Spokane and other cities at a cost to exceed $200,000.

Construction projects are as follows: The Mission Rock Company, Harry S. Scott, president, San Francisco, Calif., plans a cold storage and refrigerating plant to cost $200,000. The Truckee Utility District, Truckee, Calif., plans a distributing system to cost $20,000. The Hawley Pulp & Paper Company, Oregon City, Ore., plans electrification of its pulp mill. The Maple Creek Coal Company, Salt Lake City, Utah, plans extensions at its mines to cost $50,000. The Willapa Pulp & Paper Mills, Inc., South Bend, Wash., plans a pulp mill to cost $500,000. Monrovia, Modesto and San Leandro, Calif., plan installation of ornamental lighting systems. The Southern Sierras Power Company, Riverside, Calif., will build a steel tower transmission line from San Bernardino to Seal Beach, 58 miles, to cost $750,000. The Commonwealth Utilities Corporation, Denver, Colo., plans a 44,000-volt transmission line. The Pacific Power & Light Company plans transmission lines at Walla Walla, Wash., to cost $150,000, and a substation to cost $35,000.

Activities of the Trade

Railway & Industrial Gets Large Switch Order

A very large order for outdoor substation switching equipment recently has been placed by the Public Service Corporation of New Jersey with the Railway & Industrial Engineering Company of Greensburg, Pa. The order covers equipment for the West Orange, Roseland and Metuchen substations and includes the steel structures for two of the stations. The stations are for 154 kv. to 37 kv. service.

The major items that are to be furnished include 203 three-pole sets of "Hi-Pressure" contact switches, 102 motor-operating mechanisms, 1,250 interchangeable unit bus supports, 157 sets of single pole equipment and 450 tons of steel. The apparatus is similar to that furnished for the Public Service Corporation's Hudson station in 1927.

Westinghouse Accident Due to Failure of Test Apparatus

The fatal accident which occurred on March 13 in the South Philadelphia works of the Westinghouse Electric & Manufacturing Company was not due to the explosion of a turbine, as stated in the newspapers, but to the failure of part of the temporary shop equipment for testing. The accident happened during the heater box run on the low-pressure spindle of a large turbine, stated H. T. Herr, vice-president of the company. During the shop tests of a large spindle, temporary equipment is required to permit the overspeed run in a special casing installed in the erecting shop. A coupling adapter plate, which is part of this equipment used only in shop tests, burst during the test and broke the coupling housing into fragments. This is the first accident resulting in serious injury since the opening of the South Philadelphia plant ten years ago.

Woodward Governor Confers With Hydro Operators

As a means of giving operating men and engineers a more thorough knowledge of the basic theory and practical use of its equipment for the control of hydraulic turbines, the Woodward Governor Company recently held a four-day conference at Rockford, Ill., at which 58 operators from hydro-electric plants in the United States and Canada attended. This was the second annual conference which the Woodward company has arranged and both meetings have enabled the operators and engineers who design the equipment to study and discuss operating problems and conditions encountered in a large number of hydro-electric plants.

Methods by which highest efficiency and most accurate control could be obtained were demonstrated by actual operation of governors and the use of cut-away views of various types of machines. The final day of the conference was devoted to a general discussion of power plant operation and new types of machinery were suggested to be developed so that certain local plant conditions might be handled automatically. Both the governor company and the plant operators felt that the conference was a very definite benefit and plans have been made to hold such a meeting each year.

American Pulverizer Moves Into New Plant

A new modern plant located at 1249 Macklind Avenue, St. Louis, is now the home of the American Pulverizer Company, manufacturer of the American rolling ring crushers. The company was formerly at Eighteenth and Austin Streets. The new plant has about 12,000 sq.ft. of floor space, is equipped with modern machinery, including an electric traveling crane, and is served with a private switch track connecting with the principal railroads. It is said that the company is now in a position to better than double its former production.

THE ALLIS-CHALMERS MANUFACTURING COMPANY, Milwaukee, announces that E. D. Hill will represent the company at 42 Church Street, New Haven, Conn. The sales will be under the direction of A. F. Rolf, manager of the company's New York office at 50 Church Street.

THE BLACK & DECKER MANUFACTURING COMPANY, Towson, Md., manufacturer of portable electric tools, announces the electric sander for smoothing surfaces.

THE WODACK ELECTRIC TOOL CORPORATION, 4627 West Huron Street, Chicago, announces the type B portable electric hand saw, which, in addition to vertical sawing, provides for bevel sawing at any angle up to 60 deg.

THE NATIONAL CARBON COMPANY, INC., Cleveland, announces the removal of the branch sales office and factory of the carbon sales division from 357 West 36th Street, New York City, to new and larger quarters at the company's plant at Fourteenth and Henderson Streets, Jersey City, N. J.

THE ELECTRIC VACUUM CLEANER COMPANY, INC., Cleveland, announces that M. R. Sutherland and Harry C. Hahn have been appointed assistant sales managers. Mr. Sutherland assumes entire charge of organization matters and is responsible for the personnel of the field organization, while Mr. Hahn is responsible for trade relations and is essentially a contact and sales promotion man. He will have as his personal staff three regional representatives bearing the title of manager of trade relations. These men are Otto Best, Jr., with headquarters in New York City; Walter J. McCord, Jr., with headquarters at Cleveland, and G. L. Lord, with headquarters at Chicago. V. M. Cannon has been appointed assistant to the sales manager.

THE FEDERAL ELECTRIC COMPANY, 8100 South State Street, Chicago, announces a new product, the "Fedelco" porcelain electric clothes washer.

THE DELTA-STAR ELECTRIC COMPANY, 2400 Block, Fulton Street, Chicago, announces the opening of a new Kansas City, Mo., office in charge of L. C. Hitzeroth, who has been transferred from the sales engineering division of the Chicago factory.

THE SUNDH ELECTRIC COMPANY, Newark, N. J., manufacturer of control apparatus, announces the appointment of the Chas. L. Ward Company as its representative. The Ward company has offices at 701 Midland Building, 1229 Baltimore Avenue, Kansas City, Mo.; 734 Electric Building, Omaha, Neb., and Tulsa, Okla.

THE COPPERWELD STEEL COMPANY, Glassport, Pa., announces that Paul Van Wagner has been appointed representative for the Pittsburgh district in charge of central-station and railroad sales, covering the distribution of Copperweld products in western Pennsylvania, western Virginia, western Maryland and the state of West Virginia.

THE ELECTRIC MACHINERY MANUFACTURING COMPANY, Minneapolis, manufacturer of synchronous motors and vertical alternators, announces the appointment of T. H. Hayes, 705 Traction Terminal Building, Indianapolis, Ind., as its sales representative for the Indianapolis territory.

THE KRICH LIGHT & ELECTRIC COMPANY, 558 Broad Street, Newark, N. J., jobber, announces a change in policy. The company has discontinued its general electric supply business and will hereafter confine its activities to the merchandising of electric specialties, such as vacuum cleaners, refrigerators, ventilating fans, sewing machines, radio, etc.

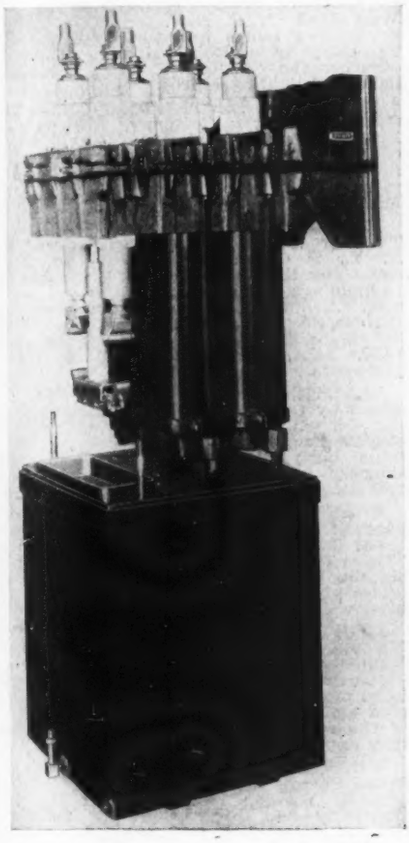
THE NATIONAL FIREPROOFING COMPANY, Fulton Building, Pittsburgh, announces that Sidney F. Heckert was elected president at the annual meeting of the board of directors held on March 2.

COPELAND PRODUCTS, INC., Detroit, announces that 35 new dealers have been added to the list of firms handling Copeland electric refrigerators, according to W. D. McElhinny, vice-president in charge of sales. The company recently demonstrated at Detroit its "Silica Gel" refrigeration unit which does not require a motor and compressor but is of the absorption type.

New Equipment Available

Compact High-Rating Oil Circuit Breaker

The type D-131 oil circuit breaker of relatively high interrupting capacity and comparatively small dimensions has been developed by the Condit Electrical Manufacturing Company, Boston. The line is built for 400, 600, 800 and 1,200 amp.



Double tank construction is used in this compact high-rating circuit breaker

at 15,000 volts, and 1,600 amp. at 7,500 volts, with an estimated interrupting capacity of 7,000 amp. at 15,000 volts. It is available in two, three and four-pole, single-throw, manually or electrically operated units. Features of the design include a double-tank construction cradle and spring suspension, a rugged frame and heavy arcing contacts.

LIMIT SWITCH FOR CONTROL CIRCUITS.—A limit switch for controlling the limits of travel on such applications as motor-operated window- or door-opening apparatus, valves, etc., where magnetic control is used has been placed on the market by the General Electric Company. The switch is provided with two normally closed contacts, one for each extreme of travel. These contacts are operated by two cams, mounted on opposite faces of a molded gear. The two cams are adjustable with respect to each other and, as a further refinement, each contact has a micrometer screw which makes possible very close adjustment of the opening point for each contact after the general position of the cams has been set. The molded gear, with the two cams, is driven by means of a worm gear. The entire mechanism is inclosed in a cast-iron box with sheet-steel covers on the front and back. The contacts are both of silver.

Heavy-Duty, Gang-Operated Disconnecting Switch

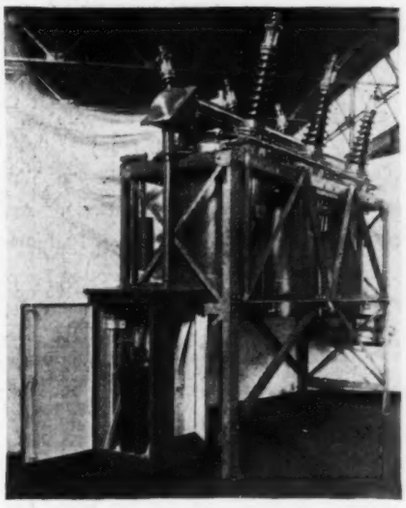
For heavy duty railway service and use on trunk feeders where the operating voltage is 11,000, the Delta-Star Electric Company, Chicago, has developed a gang-operated switch. It is equipped with corrosion and ice-breaking mechanism to insure easy and positive action at all times and is provided with ball bearings on the rotating bearings and swivel joints.

The full-floating, self-aligning contacts are fully covered by a copper sleet shield. The number of parts have been reduced to a minimum and all are said to be of exceptionally rugged construction. Although primarily designed for remote control by means of a motor mechanism, this switch can be furnished for remote manual control.

High-Voltage Outdoor Oil Circuit Breakers

The design of a new line of outdoor oil circuit breakers has just been completed by the General Electric Company. The line is designated as the FHKO-139 type with interrupting capacities ranging from 350,000 kva. to 2,500,000 kva. The breakers are built to operate on voltages from 15,000 to 220,000. The breakers, from 15,000 to 88,000 volts inclusive, are mounted on a structural iron framework, while breakers of 110,000 volts to 220,000 volts are floor mounted. The breakers are built with "A," "B" and "C" interrupting capacity ratings, the "A" breaker having the wedge and finger plain break contacts, while the "B" and "C" ratings employ the explosion chamber. The breakers are constructed of boiler plate steel welded in place. The detailed design factors, electrical clearance, stroke, pressure type joints, sizes and weights for a given voltage and interrupting capacity were decided from tests both in the factory and in the field and in conformity with the company's experience in oil circuit breaker application.

Each single-pole unit has a flame-resisting lining of high dielectric strength, an oil gage, drain and fill valves and a separating chamber. The single-pole units are made of interchangeable design in so far as is possible. A semaphore is provided for the complete breaker to indicate the position of the breaker contacts; that is, whether open or closed. The drain valves are connected to a pipe at the bottom of the oil tanks in such a way as to permit complete drainage of the oil. The oil circuit breaker contacts are operated by a mechanism for providing a simple straight line motion. Each single-pole unit is equipped with buffer springs compressed in the closed position, a toggle effective in the closed position, a toggle stop, and dashpots to prevent rebound of the contacts. Each unit is provided with a balancing spring and the complete breaker has an opening spring such that the contacts are constrained to open throughout the complete stroke. The breakers may be manually operated, solenoid operated or motor operated. Trip free mechanisms are available for either solenoid or motor applications, while alternating-current operation is provided by means of the motor mechanism, which is of the centrifugal type. For breakers up to and including 37,000 volts the standard compound filled bushings are provided. For 50,000 volts and all higher voltages oil-filled bushings are provided. Breakers of 15,000-, 25,000- or 37,000-volt ratings are so designed that the American Institute of Electrical Engineers' minute test for the next higher voltage rating may be applied.



Type FHKO-139, 73,000-volt solenoid-operated oil circuit breaker

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POLYPHASE SWITCHES.—A line of polyphase switches built in sizes ranging from 60 amp. to 400 amp. with test connections and from 60 amp. to 600 amp. without test connections has been placed on the market by the Trumbull Electric Manufacturing Company, Plainville, Conn. These switches can be furnished with fuses sealable or accessible when the switch is in the "off" position. The switch is of slate base construction and the contacts are mounted on the top where they can be inspected in the "on" position.

Electrical Patents

Announced by U. S. Patent Office

(Issued Feb. 28, 1928)

1,661,014. SHORT CIRCUITING AND BRUSH LIFTING DEVICE FOR DYNAMO ELECTRIC MACHINES; E. Schmock, Kiel, Germany. App. filed Dec. 16, 1925.

1,661,062. ELECTRICAL WATER HEATER; P. Ambory, Royal Oak, Mich. App. filed June 11, 1927.

1,661,102. ENDED CORD AND METHOD OF PRODUCING THE SAME; E. E. Waite, Framingham, Mass. App. filed Feb. 28, 1924.

1,661,103. THERMOSTATIC REGULATING DEVICE FOR HEAT-PRODUCING APPARATUS; A. O. Appelberg, Stockholm, Sweden. App. filed Nov. 3, 1925.

1,661,109. TRANSMITTER FOR ELECTRICAL CONTROL SYSTEMS OF THE SELECTIVE TYPE. Granted under the provisions of the act of March 3, 1883. R. C. Coupland, of the United States Army, Dayton, Ohio. App. filed May 13, 1926.

1,661,124. TERMINAL CLIP; H. M. Koretzky; New York, N. Y. App. filed May 7, 1923.

1,661,127. ELECTRICALLY-CONTROLLED COMBINATION MECHANISM FOR LOCKS; R. H. Malicki, Chicago, Ill. App. filed April 18, 1925.

1,661,138. INCANDESCENT LAMP RETAINER AND MOUNTING; R. M. Hill, Washington, D. C. App. filed May 28, 1923. Of the type used in motion picture apparatus.

(Issued March 6, 1928)

1,661,156. PRODUCTION OF WELDED WIRE FABRIC AND APPARATUS THEREFOR; A. Armstrong, Tynemouth, England. App. filed Nov. 18, 1924.

1,661,166. RELAY; T. S. Casner, Plainfield, N. J. App. filed April 23, 1925. Of high sensitivity adapted to be operated by relatively weak electrical impulses to open and close a local circuit of considerable magnitude.

1,661,170. ELECTRIC DRIVING SYSTEM; J. Drukker, Amsterdam, Netherlands. App. filed Jan. 7, 1927. For phonographs.

1,661,173. ELECTRIC FURNACE; C. B. Foley, Fort Wayne, Ind. App. filed March 23, 1922. Induction furnace of crucible type.

1,661,199. CONTAINER COVER; H. A. Selah, Erie, Pa. App. filed Dec. 26, 1924. Cover for conduit boxes.

1,661,208. LARGE AUTOMATIC GENERATING PLANT; E. R. Witzel, Kohler, Wis. App. filed May 14, 1927.

1,661,222. ELECTRIC HEATER; W. C. Hunt, Toronto, Ont., Can. App. filed March 12, 1927. Bowl reflecting type.

1,661,224. PRIMARY GALVANIC BATTERY; E. W. Jungner, Kneippbaden, Sweden. App. filed June 1, 1920.

1,661,258. CASE FOR FIRE ALARM SIGNALING MECHANISM AND THE LIKE; F. B. Love, and B. H. Smith, Shelby, Ohio. App. filed Feb. 17, 1925.

1,661,268. COMBINED TRANSFORMER AND CONDUIT BOX COVER; A. E. Rittenhouse, Honeoye Falls, N. Y. App. filed May 1, 1926.

1,661,281. ELECTRIC RADIATOR; J. Bilan, Flint, Mich. App. filed June 13, 1927.

1,661,303. ELECTRODE RACK; H. G. Price and B. K. Smith, Houston, Tex. App. filed Feb. 24, 1927.

1,661,331, 1,661,332. APPARATUS FOR WINDING ARMATURES; A. B. Gomory, Anderson, Ind. Apps. filed Sept. 26, 1924 and Feb. 3, 1923.

1,661,345. ALTERNATING CURRENT MAGNET; C. H. Rippl, East Cleveland, Ohio. App. filed Feb. 26, 1927. As employed in contactors, circuit breakers and the like.

1,661,346, 1,661,347, 1,661,348, 1,661,349. THERMOSTATIC CONTROLLING MECHANISM; C. B. Sawyer, Cleveland, Ohio. Apps. filed Nov. 17, 1922, April 4, 1923 and March 17, 1924. Such as depend for their operation upon the expansion or contraction of a fluid due to temperature changes.

1,661,352. ELECTRIC SWITCH; W. G. Young, Dayton, Ohio. App. filed April 30, 1925. Of the plunger type.

1,661,354. ANTI-FREEZE CONTAINER; W. W. Ayre, West Englewood, N. J. App. filed March 17, 1927.

1,661,373, 1,661,376. CONDUCTOR CLAMP; E. F. Leighton, Anderson, Ind. Apps. filed March 15, and June 7, 1926.

1,661,434. ELECTRIC SWITCH AND SYSTEM; A. R. Locke, Chicago, Ill. App. filed Aug. 14, 1922. As applied to a multi-color lighting system such as used in theatre stages and auditoriums.

1,661,464. HEATING ELEMENT SUPPORT; W. Campbell, Detroit, Mich. App. filed Aug. 13, 1923.

1,661,495. SWIVEL CONNECTION; P. M. O'Neill, Fort Ethan Allen, Vt. App. filed Aug. 4, 1925.

1,661,497. BATTERY TERMINAL; G. D. Pate, Akron, Ohio. App. filed April 25, 1925. For storage battery.

1,661,553. VACUUM CLEANER ATTACHMENT; L. Baar, Los Angeles, Cal. App. filed March 19, 1927.

1,661,585. SYSTEM OF RECTIFICATION; F. Transom, Washington, D. C. App. filed April 2, 1925.

1,661,589. ANODE SPACER; W. J. Winninghoff, East Orange, N. J. App. filed Aug. 27, 1924.

1,661,597. WATER-COOLED LAMP; L. J. Buttolph, East Orange, N. J. App. filed Jan. 1, 1924. Apparatus for controlling radiant energy devices.

1,661,622. BRAKE SYSTEM FOR VEHICLES RUNNING ON RAILS; H. Pieper, Brussels, Belgium. App. filed April 15, 1926.

1,661,625. BRAKE DEVICE; H. Pieper, Brussels, Belgium. App. filed June 5, 1926.

1,661,637. DECODING APPARATUS; A. J. Sorensen, Wilkinsburg, Pa. App. filed Nov. 18, 1926.

1,661,651. ELECTROMAGNETIC APPARATUS; P. N. Bossart, Swissvale, Pa. A direct-current electromagnet operated from a source of alternating current through asymmetric units.

1,661,683. ELECTRIC HEATING SYSTEM FOR OIL PIPE LINES; C. Setzefant, Modesto, Cal. App. filed Aug. 10, 1927.

1,661,689. ELECTRIC CANDLE SOCKET; T. A. Both, Stratford, Conn. App. filed July 26, 1921.

1,661,693. ELECTRIC WATER HEATER; J. H. Ewart, London, England. App. filed July 7, 1926.

1,661,694. ELECTRIC RESISTANCE FURNACE ADAPTED FOR HEATING BY NITROGENIZATION; A. Fry, Essen-on-Ruhr, Germany. App. filed Aug. 2, 1926.

Foreign Trade Opportunities

Following are listed opportunities to enter foreign markets. Where the item is numbered, further information can be obtained from the Bureau of Foreign and Domestic Commerce, Washington, by mentioning the number:

Purchase or agency is desired in Berlin, Germany (No. 30,122), for hot air driers and electromedical appliances.

A sole agency is desired in Caracas, Venezuela (No. 30,131), for household electrical appliances and small motors and dynamos.

An agency is desired in Alexandria, Egypt (No. 30,123), for portable reading lamps and light vase adapters and wiring devices.

Purchase or agency is desired in Basel, Switzerland (No. 30,168), for lighting fixtures, including flood lights and advertising appliances.

Purchase is desired in Vancouver, Canada (No. 30,176), of lighting fixtures and electric signs.

Purchase or agency is desired in Bucharest, Rumania (No. 30,167), for electric refrigerators.

An agency is desired in Munich, Germany (No. 30,126), for tools (electric hammers).

An agency is desired in Essen, Germany (No. 30,124), for portable electric tools.

An agency is desired in Frankfort, Germany (No. 30,125), for portable electric tools.

Two agencies are desired in Berlin, Germany (No. 30,128) and (No. 30,130), for portable electric tools.

An agency is desired in Fulda, Germany (No. 30,129), for portable electric tools.

Purchase is desired in Florence, Italy (No. 30,132), of electric vacuum cleaners.

An agency is desired in Mainz, Germany (No.30,127), for electric washing machines.

Marc-Henry Bornet, 8 Rue de Rive, Geneva, Switzerland, desires to get in touch with American manufacturers of electromedical apparatus, electrical household appliances and electric refrigeration units for the purchase of such material and to eventually arrange for an agency.

New Trade Literature

STARTING SWITCHES AND PUSH BUTTON STATIONS.—Bulletins No. 209, No. 704, No. 709, No. 710, No. 720, No. 211 and No. 800 issued by the Allen-Bradley Company, Milwaukee, describe and illustrate respectively its direct-current across-the-line starting switch, alternating-current reversing switch, type J-1552, form B, across-the-line starting switch, type J-1552 form T across-the-line starting switch, type J-1552 form M across-the-line starting switch, type C-1201 direct-current automatic starter and its push button master stations.

DECORATIVE AND INDUSTRIAL LIGHTING.—A booklet issued by the Bryant Park Electric Lamp Company, 330 West 42nd Street, New York City, covers its colored lamps and their applications. The company is also distributing a bulletin covering the "Factrolite" unit, a modern industrial lighting source.

RAILWAY ELECTRIFICATION.—The General Electric Company, Schenectady, N. Y., is distributing bulletin GEA-828 and GEA-851, in which it describes the electrification of the Butte, Anaconda & Pacific railway and the electrification of the Mexican railway.

FLOODLIGHTS AND PROJECTORS.—The Crouse-Hinds Company, Syracuse, N. Y., is distributing bulletin No. 2109 describing the applications of floodlighting in buildings, monuments and signs of every sort. A number of illustrations show the various effects obtained. Bulletin No. 2106 issued by the company describes its types LCE, LCA, LDA and LDE floodlight projectors.

ELECTRIC HOISTS.—Bulletin No. 31 issued by the Chisholm-Moore Manufacturing Company, Cleveland, covers the C-M electric hoist for every purpose. It contains construction details and illustrations showing typical installations. Drawings and complete dimensions also are included.

BRAKES.—The Clark Controller Company, Cleveland, has published bulletin 102-C in which it describes the Clark "Three C" brakes. Illustrations are given showing the construction of the brakes and tables giving approximate dimensions, ratings, weights, etc., are included.

LIGHTNING ARRESTERS.—Booklet No. 248 issued by the Electric Service Supplies Company, Seventeenth and Cambria Streets, Philadelphia, entitled "Valve Characteristics of Lightning Arresters" is the fourth of a series covering the technical features of the crystal valve lightning arrester as they apply to modern lightning protection.

WINCHES.—The Silent Hoist Winch & Crane Company, 762 Henry Street, Brooklyn, N. Y., has issued bulletin No. 27 describing and illustrating the different types of Silent Hoist vertical and horizontal capstans, single and double drum winches, and self-contained units complete with electric motor and gasoline engine drive.

SWITCHBOARDS AND SWITCHING EQUIPMENT.—The General Electric Company, Schenectady, N. Y., has issued bulletin GEA-283A and GEA-582A, covering its alternating-current small plant and industrial switchboards with oil circuit breakers and its automatic switching equipment for synchronous motor-generators in lighting service.

PUMPS.—Bulletin No. 36 issued by the Beach-Russ Company, 50 Church Street, New York City, describes and illustrates its rotary pumps for various uses.

INDUSTRIAL LIGHTING.—"Points on Productive Lighting for Industry" is the title of a booklet published by the Benjamin Electric Manufacturing Company, 120 Sangamon Street, Chicago. It contains industrial lighting information, descriptions of various types of lighting equipment and their adaptation to meet specific requirements, a listing of recommended intensities for industrial uses and a chart for estimating lamp sizes for given areas.

PULVERIZING, GRINDING AND MIXING MACHINERY.—The Abbe Engineering Company, 30 Church Street, New York City, is distributing bulletin No. 23, describing and illustrating its pulverizing grinding and mixing machines.

ELECTRIC DRIVE FOR TANKERS.—The General Electric Company is distributing bulletin GEA-871, entitled "Diesel-Electric Drive for Tankers," in which it gives illustrations and data on ships equipped with the Diesel electric drive.